State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

Columbia Spotted Frog (*Rana luteiventris*) Statewide Monitoring Summary, 2012

Publication Number 13-24
Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah
Gregory Sheehan, Director

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SPOTTED FROG SUMMARY

This report summarizes the Columbia Spotted Frog (*Rana luteiventris*) surveys and monitoring activities performed by the Utah Division of Wildlife Resources' Northern, Central, and Southern regions during the 2012 field season. Columbia Spotted Frog populations are separated into three Geographic Management Units (GMUs) and ten hydrologic unit codes (HUCs) in the State of Utah. The Northern and Central regions survey activities occurred in all three GMUs (Wasatch Front, Sevier River, and West Desert). These GMUs included the following HUCs: Spanish Fork River, Utah Lake, Provo River, Jordan River, Upper Weber River, and Lower Weber River (Wasatch Front GMU); San Pitch River (Sevier River GMU); and Ibapah Valley, Snake Valley, and Tooele Valley (West Desert GMU; Report I). Monitoring units for the Southern Region (Report II) are located only in the West Desert GMU and included: Snake Valley and Tule Valley.

In general, surveys were performed statewide between 1 March and 30 June 2012. Surveys were conducted using visual encounter surveys (VES) on spotted frog egg masses. This document represents two regional reports that contain information pertaining to translocations, inventories, habitat restoration actions, and non-native species removal efforts. For consistency, reports compiled here follow a common page, table, and to a lesser degree figure layout; however, individual reports retain the authors' style and formatting structure.

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State of Utah
DEPARTMENT OF NATURAL RESOURCES
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Columbia Spotted Frog (*Rana luteiventris*) Monitoring and Management Activities in the Central and Northern Regions, 2012

I. Northern & Central Regions Report

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EXECUTIVE SUMMARY

The Utah Division of Wildlife Resources (UDWR) began monitoring populations of Columbia Spotted Frogs (*Rana luteiventris*) in 1992 and has conducted annual monitoring at known breeding locations for several populations since 1994. The purpose of these annual monitoring surveys is to collect data on the numbers and locations of egg masses deposited at breeding sites, which can be used to evaluate annual reproductive output and the distribution and abundance of breeding adults in each population. Monitoring surveys at the breeding sites of 12 Columbia Spotted Frog populations were conducted during 2012 in the UDWR Central and Northern regions. Numbers of Columbia Spotted Frog egg masses detected during surveys were higher than average for 8 of these 12 populations and were higher than in any previous year of monitoring for three populations: the Leland Harris and Ibapah Valley populations in the West Desert, and the Diamond Fork population in Spanish Fork Canyon. Egg masses of Columbia Spotted Frogs at Diamond Fork were deposited at all known breeding ponds and at two new ponds that were created in 2009-2010 during a habitat restoration project. By contrast, no egg masses were detected at Holladay Springs (in the Payson area of Utah County) and fewer egg masses were detected at the Wallsburg and Upper Provo River breeding sites in 2012 than in any previous year of monitoring. Surveys of the recently discovered Boulder Creek population, in the Provo River Subbasin, resulted in the detection of 18 egg masses, which was similar to the 22 egg masses observed during the first year that the population was monitored in 2011. Columbia Spotted Frog egg masses were observed for the second consecutive year at the Taylor's Fork repatriation site in the Weber River Drainage, but no egg masses were detected in 2012 at the repatriation sites at Shady Dell and the Swaner Preserve.

Management activities undertaken in 2012 included restoration of degraded habitats in an area encompassing three spring pools at the Mona Springs WMA in eastern Juab County. The springs in this area had become shaded by Russian olives (*Elaeagnus angustifolia*) and completely filled with submerged vegetation since 2001, which made them unsuitable as breeding sites for Columbia Spotted Frogs. Russian olives were cleared from the area and dense beds of watercress (*Nasturtium officinale*) and other nonnative aquatic plants were manually removed from each spring pool during March 2012 to improve sunlight penetration and create open water habitat. Juvenile and adult Columbia Spotted Frogs colonized each of the restored spring pools soon after the initial restoration work was completed and were present at each pool throughout the summer. Targeted removal of Western Mosquitofish (*Gambusia affinis*) in the habitat restoration area, combined with ongoing removal of American Bullfrogs (*Lithobates catesbeianus*) throughout the Mona Springs WMA was coupled with the restoration work.

INTRODUCTION

Columbia Spotted Frogs (*Rana luteiventris*) occupy several spring complexes and riparian wetlands in Utah that are scattered along the Wasatch Front, the San Pitch River corridor, and the wetlands of the Ibapah, Snake, and Tule valleys of the West Desert. These Utah populations exist along the southeast margin of the range of Columbia Spotted Frogs in North America. Columbia Spotted Frogs historically occupied a larger portion of the state than at present. The loss and degradation of wetland habitats, combined with introductions of nonnative species, has eliminated populations at many historic locations and made the management and conservation of the remaining Columbia Spotted Frog populations in Utah a high priority (Bailey et al. 2006). Effective management of these populations depends on current and reliable information regarding trends in the distribution and abundance of Columbia Spotted Frogs in Utah. Consequently, the Utah Division of Wildlife Resources (UDWR) began monitoring populations of Columbia Spotted Frogs in 1992 and has conducted annual monitoring surveys at breeding sites of most of the Utah populations since 1994 (U.S. Fish and Wildlife Service 2002). Monitoring surveys begin in March and may extend into late May or early June at higher elevation sites. The survey protocol calls for a thorough visual search for egg masses in the breeding habitats of a population, recording the precise locations of all egg masses detected during the survey, and tallying the numbers of egg masses detected. This information is used each year to assess the size and distribution of the breeding population and the level of reproductive output at each monitoring site (Ross et al. 1994). Two to four surveys are typically conducted at each breeding site of each population to ensure that the earliest breeding activities are documented, that the peak of breeding activity is captured, and that the majority of the egg masses produced during the breeding season are detected (Ammon 2001). This report summarizes monitoring data collected during 2012 at breeding sites for populations of Columbia Spotted Frogs in the UDWR Central and Northern regions, examines temporal trends in the reproductive output of these populations, and discusses new and continuing management efforts undertaken to secure existing populations and to reintroduce Columbia Spotted Frogs to repatriation sites at historically inhabited locations.

The Conservation Agreement and Strategy for Columbia Spotted Frog in the State of Utah (Bailey et al. 2006) identifies three Geographic Management Units (GMUs) in which populations of Columbia Spotted Frogs are found within the UDWR Central and Northern regions: the Wasatch Front GMU, the Sevier River GMU, and the West Desert GMU. Each GMU encompasses multiple subunits (subbasins), each of which represents a distinct drainage system to which a unique hydrologic unit code (HUC) has been assigned by the United States Geological Survey (USGS). The Columbia Spotted Frog populations and repatriation sites in the UDWR Central and Northern regions are found in five subunits of the Wasatch Front GMU (the Spanish Fork River, Utah Lake, Provo River, Upper Weber River and Lower Weber River subunits), a single subunit of the Sevier River GMU (the San Pitch River Subunit), and in three subunits of the West Desert GMU (the Ibapah Valley Subunit, Hamlin-Snake valleys Subunit, and Rush-Tooele valleys Subunit). Monitoring and management activities in each GMU and subunit are presented and discussed under separate headings in this report. The Hamlin-

Snake valleys Subunit is referred to at the Snake Valley Subunit for conciseness and consistency with past reports.

METHODS

Population Monitoring

There are 14 known populations of Columbia Spotted Frogs in the UDWR Central and Northern regions (Figure 1), of which 12 were monitored during 2012 (Table 1). The two Ibapah Valley locations shown in Figure 1 represent two clusters of breeding sites with different monitoring histories, but do not represent locations of two separate and distinct populations. The Burraston Marsh population in eastern Juab County was not monitored during 2012 due to a pipeline construction project that blocked access to the primary breeding sites of the population. The Vernon population in Tooele County has not been monitored since 2009 due to time constraints and the failure to detect egg masses during the 2005-2008 monitoring surveys. The breeding sites of the 12 populations that were surveyed in 2012 are found on private, state, tribal, and federal lands over a wide range of elevations. The dissimilar environmental conditions experienced by populations found at different elevations and in different regions of the state results in a pattern of staggered breeding seasons, with populations in low-lying wetlands breeding earlier in the spring than populations at higher elevation beaver ponds and riparian wetlands in montane environments (Table 1). However, the onset of the breeding season varies from year to year. Consequently, repeated small-scale surveys at locations referred to as sentinel sites are used to detect the onset of breeding activities and to synchronize monitoring activities with the peak of the breeding season for each population. Sites used as sentinel sites represent breeding habitats that have been used consistently for egg deposition by Columbia Spotted Frogs at the beginning of each breeding season during past annual monitoring surveys. The surveys of sentinel sites were used in 2012 to estimate the date in which breeding activities began (onset of breeding activity) for each population based on the date and developmental stage of the first egg masses detected or the date on which adult frogs were first observed in amplexus. This information was then used to schedule subsequent monitoring surveys. For most populations, peak breeding activity occurs approximately 14 days after the onset of breeding, but populations in the Provo River Subunit of the Wasatch Front GMU typically exhibit peak breeding activity within 7-10 days after the onset of breeding (Ammon 2001; Crockett et al. 2010). During 2012, the breeding sites of each population were surveyed on multiple occasions: once during the initial period of breeding activity, one or two times during peak breeding activity, and in most cases once approximately a week after the peak of breeding activity. The Holladay Springs population was an exception. It was surveyed only once, on 11 April, due to limited resources and access issues.

The protocol for each monitoring survey involved walking along shoreline habitats, wading into deeper water in areas not visible from the shoreline, and searching for egg masses and active amphibians. When an egg mass or cluster of egg masses was detected, the number of egg masses was recorded along with the UTM coordinates (NAD83 ± 5 m), water temperature (± 0.1° C), and water depth (to the nearest cm) at the deposition site. In addition, each egg mass was assigned to one of five age/developmental categories

(Table 2). Locations, age classes, and activities of all Columbia Spotted Frogs were also noted. Snout-to-vent length (SVL) measurements of frogs were recorded when they were not engaged in breeding activities and were easily accessible without disturbing the surrounding environment. The date, time, UTM coordinates, weather conditions (ambient temperature, relative humidity, wind speed and direction, and cloud cover), and water temperature were recorded at the beginning of each monitoring survey at the point where the survey began.

Repatriation

Larval and/or juvenile Columbia Spotted Frogs were stocked during recent years at three repatriation sites in Summit County in an attempt to reintroduce Columbia Spotted Frogs to locations where populations were historically present. These repatriation sites are located at the Swaner Preserve in Park City (Lower Weber River Subunit), Taylor's Fork (Upper Weber River Subunit), and Shady Dell (Provo River Subunit). The repatriation site at the Swaner Preserve was initially stocked with 731 recently metamorphosed juveniles in 2005. It was stocked with tadpoles from egg masses collected from Middle Provo River breeding sites during 2006, 2008, 2009, and 2010 (Grover et al. 2012). The Taylor's Fork site was initially stocked with egg masses collected in the Provo River Subunit in 2008 and stocked with tadpoles in 2009 and 2010. The repatriation site at Shady Dell was established in 2007 and was supplemented with tadpoles from egg masses from other Provo River populations in 2008 and 2009. The Swaner Preserve and Shady Dell sites have been surveyed annually since 2007 and 2008, respectively. The Taylor's Fork repatriation site was surveyed for the first time in 2011. Monitoring surveys were conducted at all three repatriation sites in 2012.

Habitat Restoration and Nonnative Species Control Efforts

The Mona Springs population of Columbia Spotted Frogs faces a variety of potential threats from invasive nonnative species including Russian olives (*Elaeagnus angustifolia*), which can shade breeding habitats, making them unsuitable for egg incubation (Pearl et al. 2007); American Bullfrogs (*Lithobates catesbeianus*), which may compete with Columbia Spotted Frogs during the larval stage and prey directly on larval, juvenile, and adult Columbia Spotted Frogs (Murray et al. 2004); and Western Mosquitofish (*Gambusia affinis*), which prey on amphibian eggs and newly hatched larvae (Goodsell and Kats. 1999).

Management activities at the Mona Springs WMA in 2012 emphasized removal of Russian olives from areas surrounding shaded spring pools in the northeast portion of the WMA and removal of dense beds of nonnative aquatic vegetation, particularly watercress (*Nasturtium officinale*), from the pools themselves (Figure 2). The primary objective of this habitat restoration project was to restore the spring pools to conditions favorable for Columbia Spotted Frog breeding activities. Student volunteers from the Department of Biology at Utah Valley University (UVU) were recruited to assist with Russian olive and watercress removal, much of which was coordinated by Robin Cheung, a student in the Spring 2012 UVU Conservation Biology class. These efforts began on 3 March 2012, with additional clearing of Russian olives taking place on 8 and 29 March. Nonnative

aquatic plants were removed through a combination of pulling by hand and sweeping the water column with long-handled rakes. Russian olives were cut using chainsaws and bow saws and the stumps of cut trees were treated with Garlon 3A® to kill root systems and prevent regrowth. All Russian olives bordering spring pools in the north and central portions of the habitat restoration area were cut and removed, but some Russian olives were left standing in the vicinity of the southernmost spring pool. Additional thinning of nonnative aquatic vegetation and thinning and girdling of large Russian olives by UDWR biologists took place on 12 April, 25 July, and 30 November 2012. In addition, a shallow cove at the northeast end of the middle spring pool in the habitat restoration area was excavated, using a shovel, to provide suitable shallow-water habitat for egg deposition by Columbia Spotted Frogs (Figure 3). A similar cove was created in a sediment filled portion of the west shoreline of the southernmost spring pool in the habitat restoration area, which added to the amount of open-water habitat from which aquatic vegetation had been cleared and increased the amount of shallow shoreline habitat suitable for egg deposition within the spring pool. The spread of invasive aquatic vegetation had resulted in a complete loss of open water habitat in this pool, but thinning of shoreline Russian olives and removal of watercress, combined with transplanting of southern cattails (*Typha domingensis*) from nearby habitats, restored the spring pool to conditions more favorable to Columbia Spotted Frogs (Figure 4).

A secondary management objective at Mona Springs in 2012 was to reduce abundances of nonnative fishes and bullfrogs at restored habitats as a means of enhancing their suitability as habitats for larval and juvenile Columbia Spotted Frogs. Mosquitofish rapidly increased in abundance and bullfrogs quickly colonized spring pools following Russian olive and watercress removal. In an attempt to reverse this trend, a total of 4695 mosquitofish were trapped and removed from the habitat restoration area and adjacent areas of the spring complex on several occasions from 12 April until 30 November 2012. An unrecorded number of larval and juvenile bullfrogs were captured and euthanized during this effort. In addition, 37 basking adult and subadult bullfrogs were euthanized and three bullfrog egg masses were discovered and removed during expanded bullfrog removal efforts that encompassed the entire eastern portion of the Mona Springs WMA.

Pathogen and Biosecurity Measures

Several precautions were taken before and after each monitoring survey to minimize the possibility of transferring pathogens and other organisms from one site to another. Following each visit to a site, all mud and debris was removed from boots and equipment, which were then treated with a 1:100 solution of Quat-128™ (which is a pH-neutral disinfectant containing quaternary ammonia) and allowed to dry before being used again at another site. Equipment was exposed to direct sunlight for two or more days between uses to ensure thorough drying and maximize exposure to UV light as often as the timing of the surveys and the weather conditions permitted.

RESULTS

Wasatch Front GMU

Provo River Subunit

At least four populations of Columbia Spotted Frogs are present in the Provo River Subunit. Two of the populations, the Middle Provo River (Heber Valley) and Upper Provo River populations, are widely distributed over numerous breeding areas. The Middle Provo River population occupies an array of ponds and riparian wetlands that were created during the Provo River Restoration Project (PRRP) along roughly 15 km of the Provo River riparian corridor between Jordanelle Reservoir and Deer Creek Reservoir in Wasatch County. The Upper Provo River population occupies riparian wetlands and beaver ponds on State Park, United States Forest Service (USFS), and private lands upstream from Jordanelle Reservoir along approximately 30 km of the upper Provo River riparian corridor. A breeding site for a third population exists roughly 10 km to the south of the Heber Valley at a pond on private land in Wallsburg (Wasatch County), which has been surveyed annually since 2008. This pond is the only known breeding site for the Wallsburg population, but restricted access to adjacent parcels of private land has precluded a thorough survey of potential breeding habitats in Wallsburg. A fourth population of Columbia Spotted Frogs in the Provo River Subunit was discovered by U.S. Forest Service biologists in 2010 at Boulder Creek, a tributary to the North Fork of the Provo River. It was monitored for the first time in 2011. The known breeding sites for each of these four populations were surveyed during 2012.

Monitoring of populations of Columbia Spotted Frogs in the Provo River Subunit began on 5 April and continued until 1 May in 2012. The total number of egg masses detected during monitoring surveys of these populations was 1025, with 18 detected at Boulder Creek, 227 detected at Upper Provo River monitoring sites, 779 at Middle Provo River monitoring sites, and one at the pond in Wallsburg (Table 3). The 227 egg masses detected in 2012 at breeding sites of the Upper Provo River population was the lowest on record and represents the continuation of a decline that began in 2011 (Figure 5). The 779 egg masses detected at breeding sites for the Middle Provo River population was typical of levels of reproductive output seen since 2004, which followed a period of population expansion that coincided with the completion of habitat restoration undertaken as part of the PRRP (Figure 6). The 18 egg masses detected at breeding sites of the Boulder Creek population in 2012 was comparable to the 22 egg masses detected during the only previous year of monitoring in 2011. Very few egg masses (1-6 per year) have been detected during each of the five years of monitoring at Wallsburg (Table 4).

The repatriation site in the Provo River Subunit, at Shady Dell, was surveyed for Columbia Spotted Frogs and egg masses on 3 May and 9 May of 2012. No Columbia Spotted Frogs or egg masses were observed. The Shady Dell site was first stocked during the spring of 2007 and has been surveyed every year since that time. The most recent stocking of Columbia Spotted Frog tadpoles at Shady Dell occurred on 20 May 2009. Female Columbia Spotted Frogs typically require 3-6 years to reach sexual maturity (males mature 1-2 years earlier), with females from high elevation sites growing slower,

maturing at smaller sizes, and taking longer to mature than females from lower elevation sites (Turner 1960; Licht 1975; Reaser 2000). Consequently, it is possible that Columbia Spotted Frogs from the 2009 stocking survived until 2012, but that surviving females had not yet reached sexual maturity.

Upper and Lower Weber River Subunits

The Taylor's Fork repatriation site in the Upper Weber River Subunit was surveyed for Columbia Spotted Frogs and egg masses on 24 April, 3 May, and 9 May of 2012. Nine egg masses were detected during these surveys, confirming that reproduction occurred for the second consecutive year at Taylor's Fork in 2012. Eleven egg masses were detected during monitoring surveys in 2011, which was the first year that reproduction occurred at the repatriation site. Taylor's Fork was stocked with larval Columbia Spotted Frogs on 27 May 2008, 14 May 2009, and 28 May 2010. The 2011 and 2012 monitoring data indicated that females reached sexual maturity in as little as three years and that the number of breeding females was similar in 2011 and 2012.

A visual encounter survey was conducted on 25 April 2012 at the Swaner Preserve of the Lower Weber River Subunit in an attempt to locate Columbia Spotted Frogs or egg masses. The timing of the survey was synchronized with the peak of breeding activity for the Upper Provo River population of Columbia Spotted Frogs, which is the closest population found at elevations similar to those of the Swaner Preserve. No egg masses or Columbia Spotted Frogs were detected, despite an exhaustive search of all potential breeding habitats within the preserve. Breeding adult Columbia Spotted Frogs were present and produced egg masses at the Swaner Preserve during 2008 and 2009, but there has been no evidence of subsequent breeding activity or persistence of the population. Supplemental stocking of Columbia Spotted Frog tadpoles occurred at the preserve during 2009 and 2010, which leaves open the possibility that juveniles may still be present. However, no juvenile or adult Columbia Spotted Frog juveniles have been detected now for three consecutive years during which thorough searches of the preserve were conducted.

Spanish Fork River Subunit

Monitoring of Columbia Spotted Frog populations in the Spanish Fork River Subunit began on 21 March and continued until 16 April in 2012. The total number of egg masses observed was 231, with 215 detected at Diamond Fork, 16 detected at Springville, and none detected at Holladay Springs (Table 3). The 215 egg masses at Diamond Fork was the highest number detected since monitoring began there in 2003 (Table 4), and represents the second consecutive year of unprecedented reproductive output (Figure 7). The Springville population exhibited a period of relatively high reproductive output from 1997 through 2000, but experienced a decline from 2001 to 2009. The 2011 total of 81 egg masses was the highest since 1998, suggesting that the population of breeding adults had increased substantially, but this increase proved to be transitory. The Columbia Spotted Frog population at Holladay Springs was once robust, but reproduction has been extremely limited since 2003 (Figure 7). The breeding habitat of the Holladay Springs population is on private land where Western Mosquitofish are abundant and North

American Beavers (*Castor canadensis*) are trapped to protect large willow and cottonwood trees. These trees now shade all shallow shoreline habitats in the area (M. C. Grover, personal observation).

Observations of Columbia Spotted Frogs and egg masses at Diamond Fork indicated that the area used for breeding activities by the population expanded during 2011 and 2012. A pond excavated during habitat restoration work in 2009 was used as a breeding site for the first time in 2011. This pond was used again for egg deposition in 2012, as was a nearby pond to the east that was also created during habitat restoration work. Of the 215 egg masses that were detected in 2012 at Diamond Fork, 26 (12%) were in these two recently created ponds. In addition, egg masses were found in every body of water in which breeding activity has been documented in the past, indicating that the population used all established breeding habitats and continued to expand into recently restored habitats during 2012.

Utah Lake Subunit

Monitoring of the Mona Springs population began on 20 March in 2012 and continued until 17 April. Egg masses of Columbia Spotted Frogs were first detected on 29 March and a total of 64 egg masses were detected by the time of the fourth and final monitoring survey on 17 April (Table 3). The Mona Spring population apparently experienced an increase in the number of breeding adults in 2008 and has exhibited relatively high levels of reproductive output since then (Figure 8). The 64 egg masses detected during 2012 was the fourth highest number detected during 18 years of monitoring at Mona Springs (Table 4).

Multiple Columbia Spotted Frogs colonized the habitat restoration area at Mona Springs soon after the initial thinning of Russian olives and watercress took place. Three Columbia Spotted Frogs (an adult female, an adult male, and a juvenile measuring 39 mm SVL) were captured in minnow traps during mosquitofish removal efforts in the spring pool at the south end of the habitat restoration area on 24 April. Columbia Spotted Frogs were also observed at all three restored spring pools on 19 June, 3 July, and 25 July. In addition, several young of the year juveniles (SVL=27-30 mm) were captured during seining of the southern and middle spring pools on 25 July. The exact number captured on 25 July was difficult to determine, since some of the juveniles may have been captured more than once during successive seine hauls, but was probably in the range of 8-12 individuals. A few additional Columbia Spotted Frogs (including one mortality likely caused by an avian predator) were observed or captured in the habitat restoration area during August, and an adult female (SVL= 69 mm) was captured in a minnow trap at the middle spring pool during Least Chub (*Iotichthys phlegethontis*) sampling on 2 September 2012.

Sevier River GMU

San Pitch River Subunit

Breeding sites of Columbia Spotted Frogs in the San Pitch River Subunit consist of isolated ponds, clusters of ponds, and marshes extending along approximately 12 km of the San Pitch River corridor in the vicinity of the town of Fairview in Sanpete County. All of these breeding sites are on private land and most of them are separated from other breeding sites by agricultural fields, housing developments, and highways that limit between-site migration. Eight breeding sites have been monitored each year by UDWR biologists during 1994-2012. Egg masses of Columbia Spotted Frogs were detected at six of the eight monitoring sites during 2012.
Monitoring surveys were conducted on 22 March, 30 March, and 9 April, with active adult Columbia Spotted Frogs present at breeding sites by the time of the 22 March survey, but egg masses not observed until 9 April. The estimated onset of breeding was 1 April and the total number of egg masses detected during monitoring surveys was 36 (Table 3).

The reproductive output of the Fairview population of Columbia Spotted Frogs has been relatively low since annual monitoring of the population began in 1994. The 36 egg masses detected in 2012 represented the highest level of reproductive output documented since 2000 and the second highest tally of egg masses on record (Table 4). Habitat loss and fragmentation have undoubtedly caused past declines in the distribution and abundance of the Columbia Spotted Frogs in the Fairview area, but available data indicates that the breeding population has not declined during the past two decades (Figure 9).

West Desert GMU

Ibapah Valley Subunit

Columbia Spotted Frog monitoring surveys were conducted at Ibapah Valley on 30 March and 10 April during 2012. Columbia Spotted Frogs are widely distributed in the wetlands of the Ibapah Valley, and it is likely that some degree of migration occurs between breeding sites in the north end of the valley that are designated as North Ibapah monitoring sites and those designated as South Ibapah monitoring sites at the opposite end of the valley. Separate monitoring data have been reported for these two regions of monitoring sites because of differences in their habitat characteristics, land ownership, and monitoring history. Surveys at the current set of breeding habitats designated as North Ibapah monitoring sites began in 2006. Surveys of the South Ibapah breeding sites have been conducted every year since 1997, except during 2008. The number of egg masses detected at North Ibapah in 2012 was 2410, which was more than five times higher than the 2011 total of 470 egg masses and marked the third consecutive year of unprecedented increases in reproductive output at North Ibapah (Figure 10). The total number of egg masses detected at South Ibapah in 2012 was 571, which was lower than the 2011 total of 683 egg masses, but still represented the second highest number of egg

masses detected during 1997-2012 (Table 4). The combined number of 2981 was more than twice the number of egg masses detected during 2011.

The large amount of wetland habitat in the Ibapah Valley precludes surveys of all potential Columbia Spotted Frog habitats. However, some habitats outside of the monitoring areas are the subject of ongoing management efforts to protect and enhance Columbia Spotted Frog habitats. A survey was conducted at a pond on BLM land in the southwestern portion of Ibapah Valley on 10 April 2012 to provide data to assess the effectiveness of ongoing management activities related to improving the condition of breeding habitats of Columbia Spotted Frogs at the site. An adult male Columbia Spotted Frog and six egg masses had been observed during a single survey at the pond in 2011. All six of the egg masses discovered in 2011 were dead as a result of siltation caused by livestock grazing. Breeding activity was much higher in 2012 than in 2011, with 74 egg masses deposited in five different clusters in shallow shoreline habitats along the southern half of the pond. All 74 egg masses were in good condition, with egg masses in every stage of development at the time of the survey. A project to protect the shoreline habitats used by Columbia Spotted Frogs for egg deposition at the pond was planned and organized by Traci Allen (a biologist with the BLM) and completed after the spring breeding season in 2012. The project consisted of partial fencing to exclude cattle from most of the sensitive breeding habitats and to stabilize shoreline sediments to minimize erosion and reduce turbidity.

Snake Valley Subunit

The northernmost two of the five spring complexes in the Snake Valley that support populations of Columbia Spotted Frogs are found within the UDWR Central Region. These two spring complexes are referred to as Miller Springs and the Leland Harris Spring Complex. Miller Springs receives seasonal discharge of water flowing through a broad marshy channel from the Leland Harris Spring Complex, which is located about 2.5 km to the south. Surveys for Columbia Spotted Frogs conducted at the Leland Harris Spring Complex in 2012 took place on 14 March, 27 March, and 3 April. Miller Springs was surveyed on 13 March, 26 March, and 2 April. The number of egg masses detected during 2012 at the Leland Harris Spring Complex was 2967, which was far higher than the typical reproductive output of the population, exceeding the previous high of 1740 egg masses in 2011 by more than 1200 egg masses (Table 4). The number of egg masses detected during 2012 at Miller Springs was 1276, which was the third highest tally recorded during 1995-2012. The combined total of 4243 egg masses for the Leland Harris and Miller Spring populations of Columbia Spotted Frogs in 2012 was higher than the combined total from any previous year of monitoring (Figure 11). The long term monitoring data from the two Snake Valley populations of Columbia Spotted Frogs in the Central Region indicate that 1998-2002 was a period of relatively high reproductive output. The 2011-2012 data indicate that another period of sustained high reproductive output may have begun.

DISCUSSION

Populations of Columbia Spotted Frogs in the West Desert GMU appear to have been influenced by large-scale environmental factors that favored high reproductive output during 2012. Numbers of egg masses detected during monitoring of West Desert populations in 2012 ranged from 187% of the average from past years for the Miller Springs population to 518% of the average from past years for the North Ibapah population. Possible climatic factors that prevailed throughout the West Desert GMU included extremely high precipitation levels during 2011, which carried over into high water levels at wetland habitats during the early spring period of 2012, and an unusually mild winter during 2012 (Utah Climate Center 2011, 2012). Mild winters can increase the abundance, reproductive output, and viability of Columbia Spotted Frog populations by enhancing over winter survival (McCaffery and Maxell 2010; McCaffery et al. 2012). Most of the other populations of Columbia Spotted Frogs in the UDWR Central and Northern regions exhibited moderate to high reproductive output in 2012 relative to past years. The most notable exception was the Upper Provo River population, where the 227 egg masses detected at breeding sites in 2012 was about 45% of the average from past years (Table 4).

Wasatch Front GMU

Provo River Subunit

The metapopulation of Columbia Spotted Frogs distributed along the Upper Provo River, upstream from Jordanelle Reservoir, exhibited a fairly consistent level of reproductive output during 2003-2010, followed by a slight decline in 2011 and a larger decline in 2012 (Figure 5). Whether this recent decline in reproductive output can be attributed to a decline in the population of adult Columbia Spotted Frogs along the Upper Provo River is unknown because reproductively mature females inhabiting relatively cool high elevation habitats tend to produce once every two to three years, rather than annually (Licht 1975; Reaser 2000; McCaffrey and Maxell 2010). The breeding habitats of Columbia Spotted Frogs along the upper Provo River range in elevation from approximately 1900 to 2200 m above sea level, which is near the upper elevational range of Columbia Spotted Frogs in Utah. The extreme environmental conditions at these elevations can have an impact on both reproductive output and adult survival, with survival being lowest during severe winters characterized by cold temperatures and deep snowpack (McCaffrey and Maxell 2010; McCaffery et al. 2012). The winter of 2012 was relatively mild and dry within the Wasatch GMU (Utah Climate Center 2012). However, the winter of 2011 was characterized by record high levels of spring snowpack accompanied by several spring snowstorms that brought cold conditions to the Wasatch Mountains during the Columbia Spotted Frog breeding season (Utah Climate Center 2011). If mortality rates associated with extreme climatic conditions in 2011 were unusually high, the adult population may have declined enough to reduce reproductive output between 2011 and 2012.

The recently discovered population of Columbia Spotted Frogs at Boulder Creek occupies habitats reaching elevations as high as 2500 m, and likely experiences even more extreme environmental conditions than the Upper Provo River population. The

Boulder Creek population was monitored at multiple breeding sites for the first time in 2011, with a total of 22 egg masses detected at three breeding sites. Mortality of adults, juveniles, and embryos was recorded during May and June of 2011 and was attributed to late season snowfall and cold weather (S. McKay and P. Thompson, unpublished data). However, monitoring surveys conducted at the known breeding sites of the Boulder Creek population in 2012 detected 18 egg masses, indicating that reproductive output was similar in 2011 and 2012. Whether this level of reproductive output is typical is unknown, since the population has only been monitored for two years.

The Middle Provo River population of Columbia Spotted Frogs exhibited consistently high levels of reproductive output during 2004-2012. Columbia Spotted Frog monitoring surveys detected between 372 and 491 egg masses per year during 1996-2001, followed by a steady increase from 557 to 782 egg masses during 2002-2004, which represents the period when Columbia Spotted Frogs from cohorts produced during the restoration project were reaching reproductive maturity. Reproductive output has remained consistently high since that time (Figure 6). The monitoring dataset spanning the 1996-2012 period indicates that the Provo River Restoration Project successfully restored breeding habitats and enhanced reproductive output of Columbia Spotted Frogs along the Middle Provo River in Heber Valley and that the population is currently stable.

The Columbia Spotted Frog population at Wallsburg was monitored for the fifth consecutive year in 2012. Numbers of egg masses detected during these surveys have been consistently low (1-6 egg masses per year), but only a single breeding pond has been surveyed due to restricted access to potential breeding habitats on nearby parcels of private land. It is unlikely that the population is currently restricted to one breeding pond, but the extent of the population will remain unknown without cooperation from more land owners and support for expanded monitoring.

The Shady Dell repatriation site has been surveyed every year since larval Columbia Spotted Frogs were stocked there in 2007. No egg masses or Columbia Spotted Frogs have been detected during these surveys. Beaver trapping at Shady Dell occurred during 2010 and 2011, and many of the beaver dams were notched in 2011, resulting in reduced water levels and a reduction in the amount of habitat suitable for Columbia Spotted Frogs. However, by the spring of 2012 beavers had repaired the notched dams, the beaver ponds were full, and breeding Boreal Chorus Frogs (*Pseudacris maculata*) were present. The integrity and stability of the beaver ponds may be a critical determinant of whether a population of Columbia Spotted Frogs can become established at Shady Dell in the future.

Upper and Lower Weber River Subunits

The presence of egg masses at the Taylor's Fork repatriation site during monitoring surveys in 2011 and 2012 indicates that a population of Columbia Spotted Frogs is becoming established there. The future survival of individuals from cohorts stocked as recently as 2010 and from the *in situ* reproduction in 2011 and 2012 will likely play a key role in the long term viability and expansion of the population. The current trend suggests

that the Taylor's Fork population will become the first viable population of Columbia Spotted Frogs at a repatriation site in Utah.

The repatriated Columbia Spotted Frogs at Swaner Preserve produced egg masses in 2008 and 2009, but there has been no evidence of Columbia Spotted Frogs at the preserve since that time. The one pond in which egg masses were detected in 2009 has simple shoreline habitat with very little shallow-water habitat and essentially no emergent shoreline vegetation. These conditions are atypical of Columbia Spotted Frog breeding habitats (Welch and McMahon 2005; Pearl et al. 2007). Columbia Spotted Frogs were initially stocked in smaller ponds at the repatriation site where there appears to be adequate shoreline cover. These ponds serve as breeding sites for Boreal Chorus Frogs and Tiger Salamanders (*Ambystoma tigrinum*), but may lack suitable egg deposition sites for Columbia Spotted Frogs. A thorough and comparative assessment of habitat features at potential breeding ponds on the Swaner Preserve is needed to address the question of whether current habitat conditions are likely to meet the requirements of Columbia Spotted Frogs.

Spanish Fork River Subunit

The breeding population of Columbia Spotted Frogs at Diamond Fork produced more egg masses in 2012 than in any previous year of monitoring and continued to expand into recently created breeding ponds within the portion of the habitat restoration area adjacent to core breeding sites. By contrast, the number of egg masses produced by the Springville population dropped from 81 in 2011 to 16 in 2012. The spike in egg mass numbers at Springville in 2011 and the subsequent decline in 2012 coincided with fluctuations in the amount of potential breeding habitat in the area. Egg masses were widely distributed throughout much of the wetland habitat of the Springville population during the relatively wet spring of 2011, whereas dry conditions prevailed in 2012 and all 16 egg masses were concentrated in the most stable spring pools at the south end of the wetland. In addition, much of the spring discharge was flowing back underground into fissures and small sinkholes in the wetland during the Columbia Spotted Frog breeding season in 2012, perhaps as a result of low groundwater levels (M. C. Grover, personal observation). The Holladay Springs population exhibited continued evidence of a prolonged decline in 2012. During the past decade, the number of egg masses detected during monitoring surveys at Holladay Springs has ranged from zero to six, with no evidence of reproductive activity during 2004, 2007, 2010, and 2012 (Figure 7).
Differences in habitat management and land use patterns have likely been key factors related to the dissimilar trends exhibited by the three populations of Columbia Spotted Frogs in the Spanish Fork River Subunit. The Diamond Fork population has benefitted from ongoing habitat restoration and mitigation work. The two restoration ponds with the most shoreline vegetation and the most persistent surface water were used for reproduction by Columbia Spotted Frogs in 2012. These two ponds were also the closest of the restoration ponds to core breeding habitats. Continued maturation of the surrounding vegetation and a shift in 2013 to an irrigation regime that will result in an earlier diversion of water into all of the restoration ponds is expected to result in a continued expansion of the Diamond Fork population. Breeding habitats of the Springville population occur on UDWR land, which is largely protected from direct

impacts, but is vulnerable to fluctuations in water levels and is becoming increasingly isolated from other wetland habitats due to urban and suburban development. The presence of high densities of Western Mosquitofish in portions of the wetland at Springville may compound problems associated with fluctuating water levels. The Holladay Springs population is found exclusively on parcels of private land and has been subject to habitat alterations resulting from beaver trapping, introductions of nonnative species, and agriculture.

Wasatch Front GMU

Utah Lake Subunit

The Mona Springs population of Columbia Spotted Frogs is found primarily within the Mona Springs WMA, which is managed by the UDWR, but faces threats from several nonnative species, including Russian olives, American Bullfrogs, and Western Mosquitofish. The habitat restoration work begun at Mona Springs in 2012, which emphasized removal of Russian olives, watercress, and Western Mosquitofish from spring pools that were no longer suitable as Columbia Spotted Frog habitats, was a major step toward addressing these threats. Columbia Spotted Frogs responded almost immediately to habitat restoration, judging from observations of both juveniles and adults at restored spring pools soon after dense nonnative vegetation had been removed. The habitat restoration project will be completed during 2013, with the primary goals being the removal of remaining Russian olives in southern portion of the restoration area and the clearing of watercress and accumulated debris from an additional spring pool in the southwest portion of the restoration area. Continued removal of Western Mosquitofish and American Bullfrogs will accompany the removal of nonnative plants at Mona Springs in 2013.

Sevier River GMU

San Pitch River Subunit

The number of Columbia Spotted Frog egg masses detected during annual monitoring in the San Pitch River Subunit in 2012 (n = 36) was consistent with numbers detected during past years, with the exception of 2000, which saw a spike in breeding activity (Figure 9). Overall levels of reproductive output have been consistently low compared to other populations inhabiting geographic areas of similar size in Utah. Efforts to establish and finalize conservation easements, obtaining water rights, and create or restore potential breeding habitats are the focus of current management activities aimed at improving this situation.

West Desert GMU

Ibapah Valley Subunit

The North Ibapah, South Ibapah, and smaller breeding populations of Columbia Spotted Frogs in the Ibapah Valley belong to a single metapopulation consisting of demes

occupying patches of breeding habitat of widely varying size with limited migration between them. Columbia Spotted Frogs appear to have rapidly increased in numbers throughout Ibapah Valley during 2011 and 2012. Many more egg masses (n = 1153) were detected during monitoring surveys of the North Ibapah and South Ibapah breeding sites in 2011 than in any previous year of monitoring, and the 2012 total of 2981 egg masses was 259% higher than the 2011 total. Habitats of Columbia Spotted Frogs in Ibapah Valley are relatively remote and have not been severely degraded or colonized by nonnative fishes or amphibians. Most of these habitats are on private property, land belonging to the Confederated Tribes of the Goshute Indian Reservation, or BLM land. Consequently, continued efforts to identify and respond to management needs, establish conservation easements, and formulate grazing management plans will be needed to maintain the integrity and interconnectivity of breeding habitats necessary to ensure the future viability of the metapopulation of Columbia Spotted Frogs in Ibapah Valley.

Snake Valley Subunit

The two populations of Columbia Spotted Frogs in the Juab County portion of the Snake Valley, which falls within the UDWR Central Region, both exhibited high levels of reproductive output in 2012. The number of egg masses (n = 2967) detected at the Leland Harris Spring Complex indicated that a second consecutive year of unprecedented reproductive output took place in 2012, and the tally of egg masses at Miller Springs (n = 1276) was the highest since 1999. Columbia Spotted Frog habitats at Miller Springs and the Leland Harris Spring Complex have benefited from land management practices that include a rotational grazing regime designed to protect springs and marshes inhabited by Columbia Spotted Frogs and other sensitive species. The dependence of the springs and wetlands in the Snake Valley on groundwater levels and precipitation, which could potentially be altered by climate change and groundwater withdrawal, is also highly relevant to the future of Columbia Spotted Frogs in the region.

RECOMMENDATIONS

Wasatch Front GMU

Management priorities for Columbia Spotted Frog populations in the Wasatch Front GMU during 2013 will include the completion of the habitat restoration project at Mona Springs and continued monitoring of the Mona Springs and Diamond Fork populations as a means of assessing how they respond to habitat restoration projects that have resulted in increased amounts of suitable breeding habitat. Information on the numbers and locations of egg masses within these restoration areas should prove useful in refining habitat restoration strategies to better meet the habitat requirements of breeding Columbia Spotted Frogs. Continued monitoring and management of Columbia Spotted Frog repatriation sites in the UDWR Central and Northern regions will also be a priority.

The most pressing management need related to Columbia Spotted Frogs in the Wasatch Front GMU is to protect and enhance the habitats of the Upper Provo River population. The Upper Provo River population is functionally a metapopulation inhabiting semi-

isolated habitats scattered over a swath of mostly private land spanning roughly 30 km along high elevation reaches of the Provo River corridor. Migration of individuals between the local breeding populations in these habitats is undoubtedly important in maintaining the genetic diversity and viability of the metapopulation, but is limited by a variety of factors. High elevation metapopulations of Columbia Spotted Frogs in areas bisected by ridges and rivers tend to have especially limited gene flow between demes (Funk et al. 2005). In addition, connectivity between demes of Columbia Spotted Frogs is known to be negatively correlated with the presence of predatory fish, the distance between sites, and other factors related to the complexity of the terrain between breeding sites. By contrast, connectivity and gene flow is enhanced when demes occupy highly productive breeding sites in regions that experience long growing seasons (Murphy et al. 2010). The relatively low productivity, short growing season, and the presence of Brown Trout (*Salmo trutta*) along the Upper Provo River corridor are factors expected to restrict migration of Columbia Spotted Frog between local breeding habitats. In addition, recent housing developments and road construction in the area have added to the challenges posed by these factors by increasing barriers to migration in an inherently complex landscape. Continued efforts to pursue new conservation easements and strengthen existing conservation easements for parcels of private land along the Upper Provo River will be of critical importance in maintaining the viability of the Upper Provo River metapopulation of Columbia Spotted Frogs. Protecting the integrity of known breeding habitats and the habitats between them will be necessary to maintain and enhance existing levels of connectivity between demes.

Sevier River GMU

Effective management of the Columbia Spotted Frogs in the San Pitch Subunit of the Sevier River GMU will require a continued emphasis on pursuing and finalizing conservation easements, obtaining water rights necessary to maintain the integrity of breeding ponds, and exploring opportunities for habitat restoration work that includes the creation of additional breeding ponds along the San Pitch River corridor, in the vicinity of Fairview, as a means of increasing the amount of suitable breeding habitat and the connectivity between breeding habitats. Follow-up monitoring of Columbia Spotted Frogs will be necessary to evaluate the success of such projects.

West Desert GMU

Annual monitoring of populations of Columbia Spotted Frogs in the West Desert GMU will be discontinued in 2013 due to logistical and budgetary constraints. However, a renewed emphasis on monitoring of groundwater levels and habitat parameters likely to be important to Columbia Spotted Frogs in the West Desert will be needed to evaluate potential impacts to Columbia Spotted Frog habitats. Groundwater monitoring is currently an emphasis at the Leland Harris Spring Complex and Miller Springs. Groundwater monitoring will be coupled with surface water monitoring and detailed habitat surveys (emphasizing collection of bathymetric data) at the Leland Harris Spring Complex in 2013 as a means of obtaining data necessary to better understand the relationship between fluctuations in groundwater levels and changes in habitat

characteristics at spring pools and adjacent marsh habitat. Similar efforts are needed elsewhere in the West Desert GMU to guide proactive management activities.

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TABLES

Table 1. Columbia Spotted Frog populations monitored during 2012 in the UDWR Central and Northern regions. The average date for the onset of breeding activity for each population during past (prior to 2012) surveys is shown. Populations are grouped according to Geographic Management Unit (GMU) and subunit, with the USGS hydrologic unit code (HUC) shown for each subunit. Land ownership of the habitats of each population is also shown. Federal lands include Bureau of Land Management (BLM) and Forest Service (USFS) parcels.

GMU	Subunit	HUC	Population	Land Ownership	Onset of Breeding
Wasatch Front	Provo River	16020203	Wallsburg	Private	3/26
			Middle Provo River	State (PRRP)	3/25
			Upper Provo River	Private/State/USFS	4/10
			Boulder Creek	USFS	5/25
	Spanish Fork River	16020202	Diamond Fork	USFS	3/30
			Holladay Springs	Private	3/17
			Springville	State (UDWR)	3/22
	Utah Lake	16020201	Mona Springs	State (UDWR)/Private	3/24
Sevier River	San Pitch River	16030004	Fairview	Private	3/30
West Desert	Ibapah Valley	16020306	Ibapah	Private/Tribal	3/22
	Snake Valley	16020301	Leland Harris	Private/SITLA/BLM	3/13
			Miller Springs	Private	3/14

Table 2. Categories used by UDWR biologists to classify Columbia Spotted Frog egg masses according to age or developmental stage.

Category	Size and Position in the Water Column	Appearance
Class 1	Small and round (roughly the size of a golf ball) and resting on the bottom substrate or submerged vegetation	Ova have dark spherical embryos and clear outer membranes
Class 2	Expanded and floating near the surface of the water.	Ova contain oblong embryos surrounded by opaque outer membranes
Class 3	Large (up to the size of a grapefruit) and floating at the surface, with the upper layer often above water	Upper layer of the egg mass often consisting of a desiccated white crust; embryos have tails
Class 3+	Large and beginning to disarticulate and spread out within the water column	Egg membranes beginning to break down and more than half of the embryos hatched.
Dead	Variable, often fragmented	Old egg masses in which most of the embryos are white and have failed to hatch

Table 3. The estimated date of the onset of breeding activity, date of peak breeding activity, and number of egg masses detected for each Columbia Spotted Frog population monitored in the UDWR Central and Northern Regions in 2012.

GMU	Subunit	Population	Breeding			Egg mass totals
			Onset	Peak	Population	Subunit
Wasatch Front	Provo River	Wallsburg	3/31	3/31	1	1025
		Middle Provo River	3/31	4/12	779	
		Upper Provo River	4/11	4/23	227	
		Boulder Creek	4/27	5/3	18	
	Spanish Fork River	Diamond Fork	3/21	4/10	215	231
		Holladay Springs	---	---	0	
		Springville	3/12	4/7	16	
	Utah Lake	Mona Springs	3/22	3/29	64	64
Sevier River	San Pitch River	Fairview	4/1	4/9	36	36
West Desert	Ibapah Valley	Ibapah North	3/22	3/29	2410	2981
		Ibapah South	3/20	4/1	571	
	Snake Valley	Leland Harris	3/8	3/27	2967	4243
		Miller Springs	3/6	3/26	1276	

Table 4. Total numbers of egg masses detected during surveys of Columbia Spotted Frog populations in the UDWR Central and Northern regions in 2012 compared to average and median numbers from all years in which monitoring has taken place at current monitoring sites for each population. The 25-75% quartile range (middle 50%) of the values and the rank of the 2012 total (with years ranked from the lowest to highest number of egg masses detected) is also shown for each population.

Population	2012 Egg Mass Total	Data from all Years of Monitoring				
		Average	Median	25-75% Range	Time Span	2012 Rank
Wallsburg	1	3	2	3, 6, 2, 2, 1*	2008-2012	1 of 5
Middle Provo River	779	671	629	438-800	1996-2012	11 of 17
Upper Provo River	227	509	495	448-556	2003-2012	1 of 10
Boulder Creek	18	20	21	21, 18*	2011-2012	1 of 2
Diamond Fork	215	100	95	77-121	2003-2012	10 of 10
Holladay Springs	0	39	6	2-49	1994-2012	2.5 of 19
Springville	16	25	15	9-35	1994-2012	12 of 19
Mona Springs	64	40	33	19-58	1995-2012	14 of 18
Fairview	36	25	24	19-31	1994-2012	18 of 19
Ibapah North	2410	465	74	59-298	2006-2012	7 of 7
Ibapah South	571	256	182	148-329	1997-2012[§]	14 of 15
Leland Harris	2967	737	572	436-687	1995-2012	18 of 18
Miller Springs	1276	683	356	246-1178	1995-2012	16 of 18

*Values from all years of monitoring are shown, sequentially, rather than the quartile range.
[§] Monitoring of the Ibapah South population was not conducted in 2008.

FIGURES

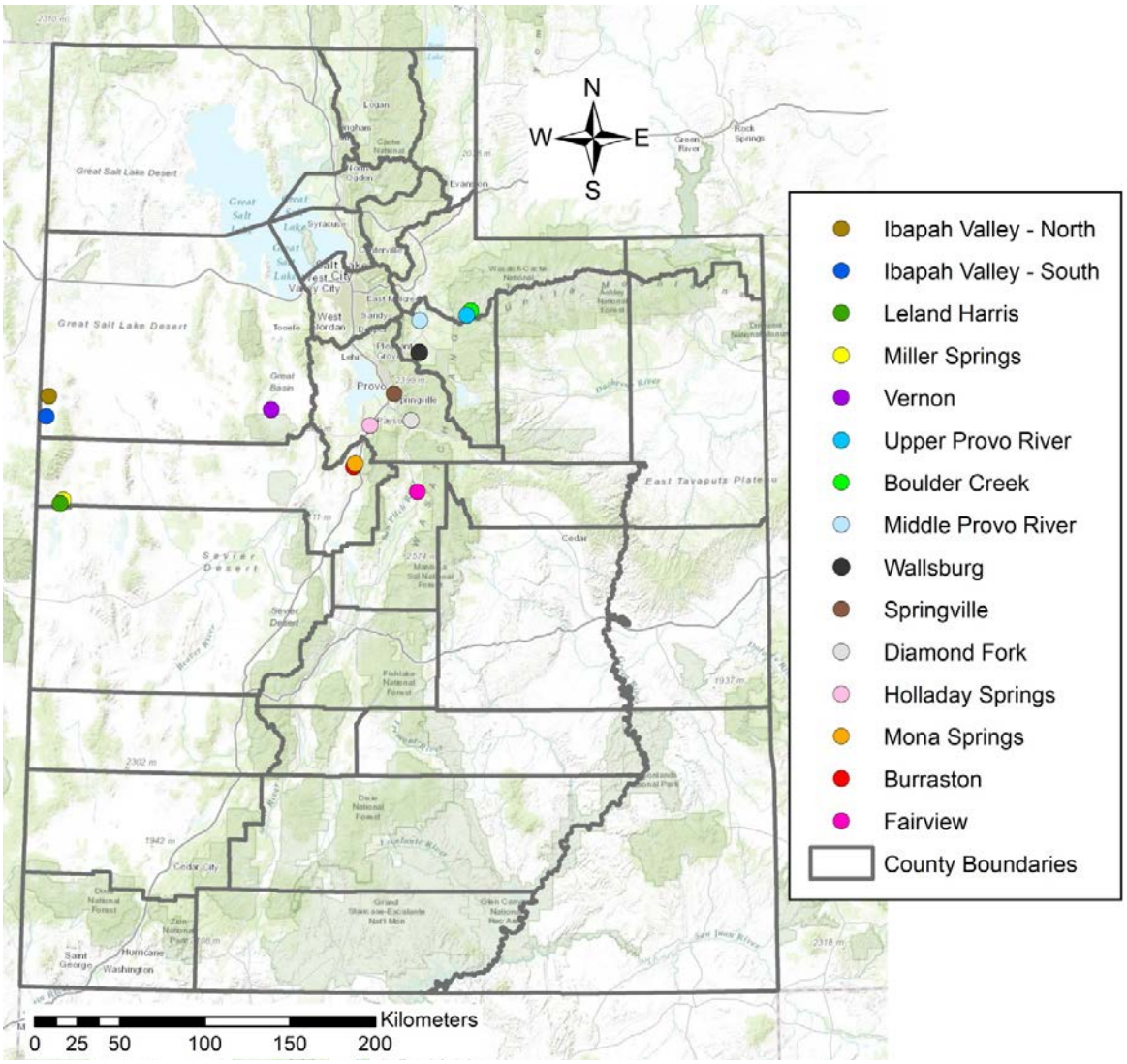


Figure 1. Locations of Columbia Spotted Frog populations in the UDWR Central and Northern regions. The Vernon and Burraston Marsh populations were not monitored in 2012.

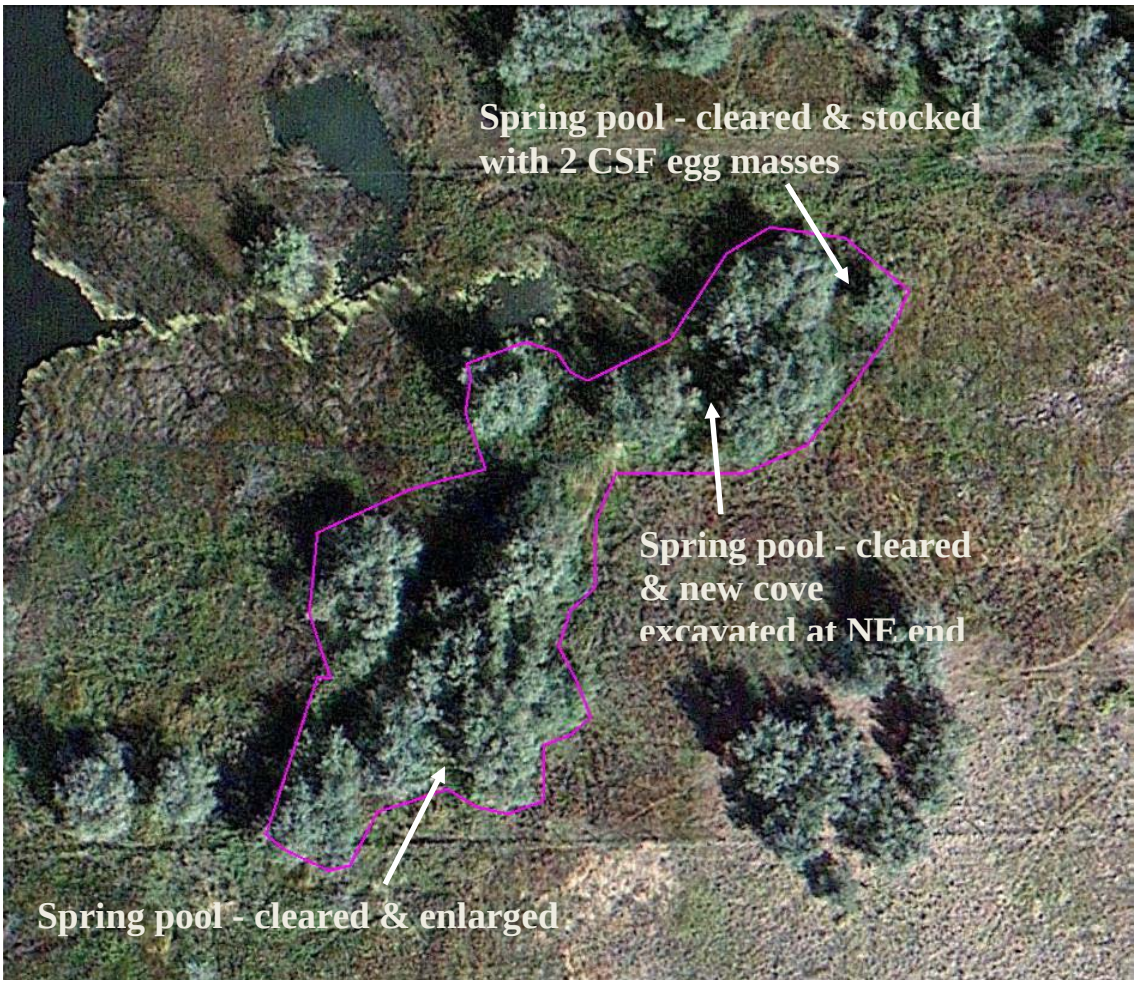


Figure 2. Area (outlined in magenta) in which Russian olives were cut or thinned and watercress was removed from spring pools during 2012 at the Mona Springs Wildlife Management Area. Imagery is from Google Earth®, 24 September 2011.

Figure 3. A newly excavated shallow cove along the channel from a spring in the habitat restoration area at Mona Springs, with the spring pool and a pile of cleared Russian olives in the background.

Figure 4. A spring at the south end of the habitat restoration area at Mona Springs that was photographed after a combination of overgrazing by livestock, eutrophication, and the spread of watercress (*Nasturtium officinale*) resulted in the loss of open water habitat in 2003 (top photo); and the same spring photographed on 30 November 2012 following removal of submerged vegetation and thinning of Russian olives (bottom photo).

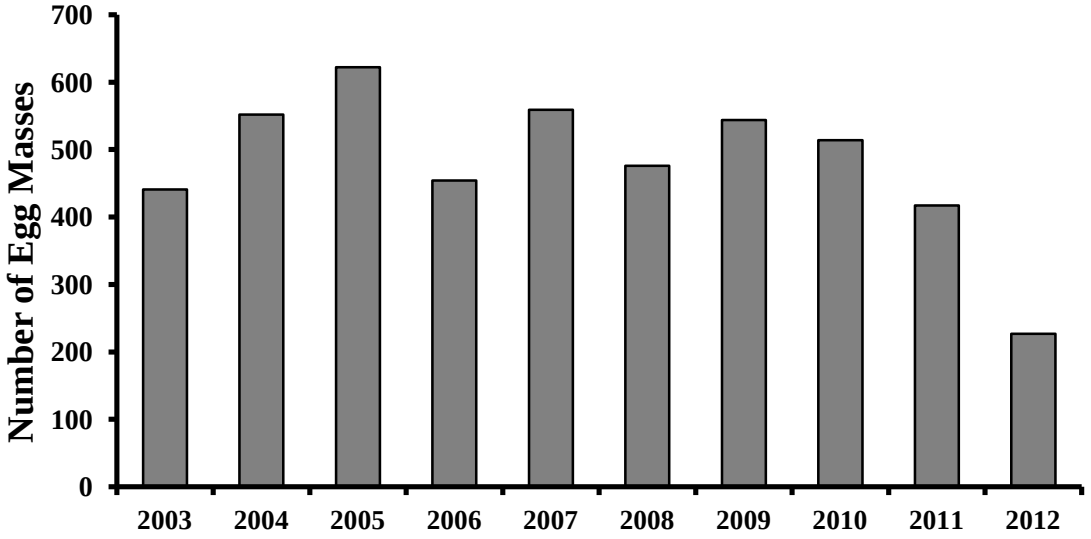


Figure 5. Numbers of Columbia Spotted Frog egg masses detected during annual monitoring from 2003 to 2012 at monitoring sites for the Upper Provo River population. Annual monitoring occurred prior to 2003, but took place at a subset of the current monitoring sites.

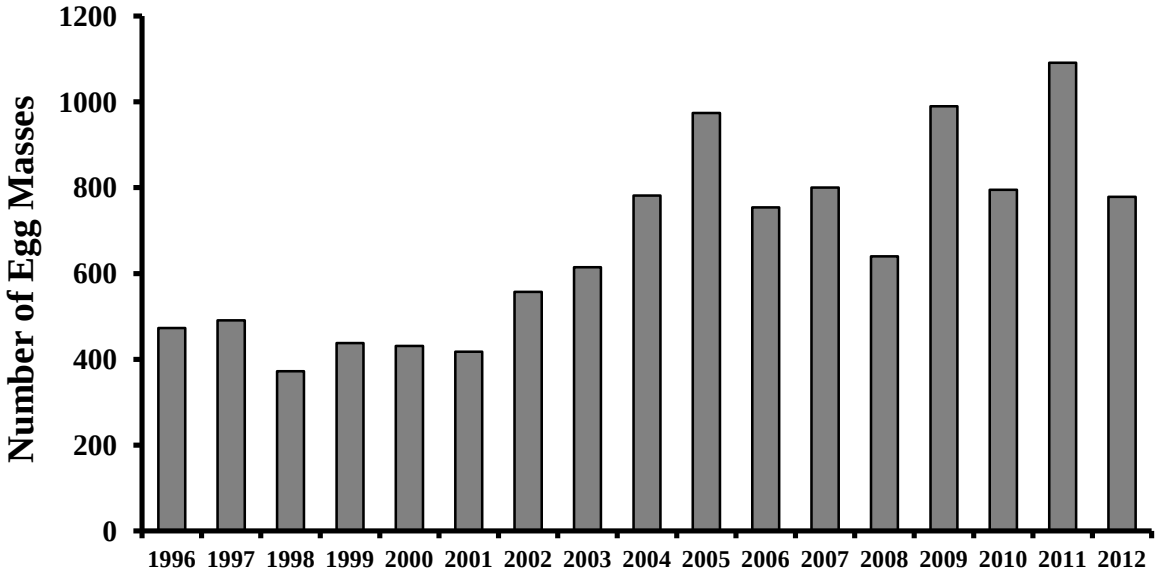
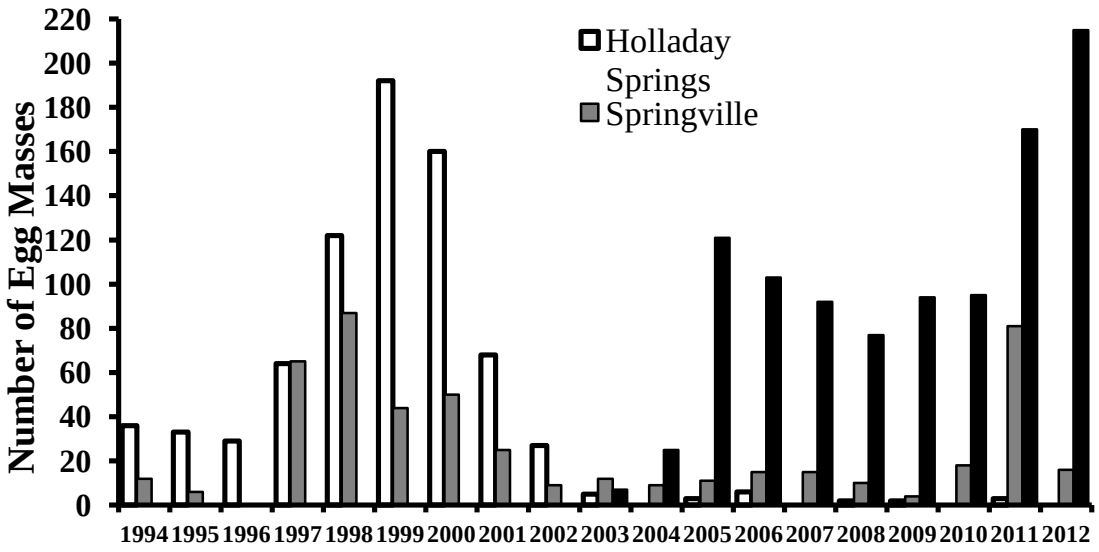


Figure 6. Numbers of egg masses detected during annual monitoring from 1996 to 2012 at Middle Provo River monitoring sites.



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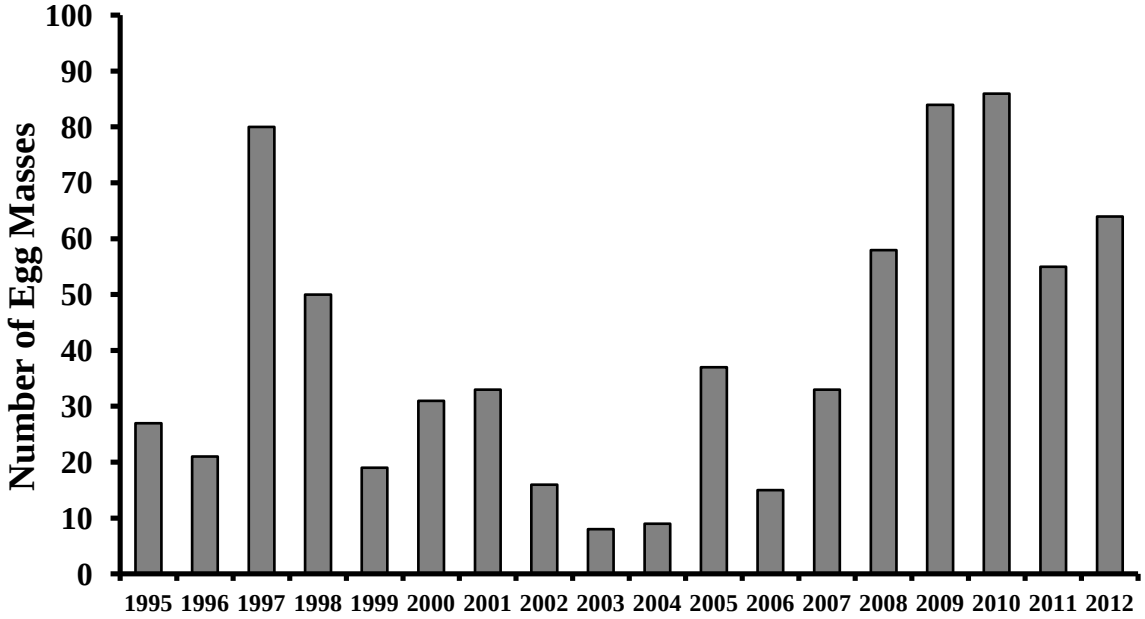

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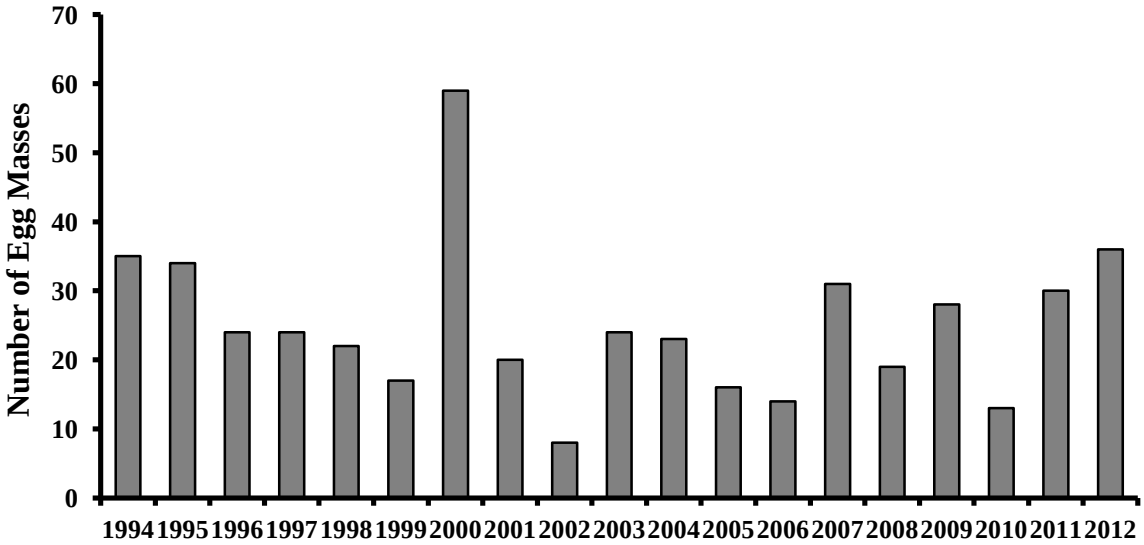

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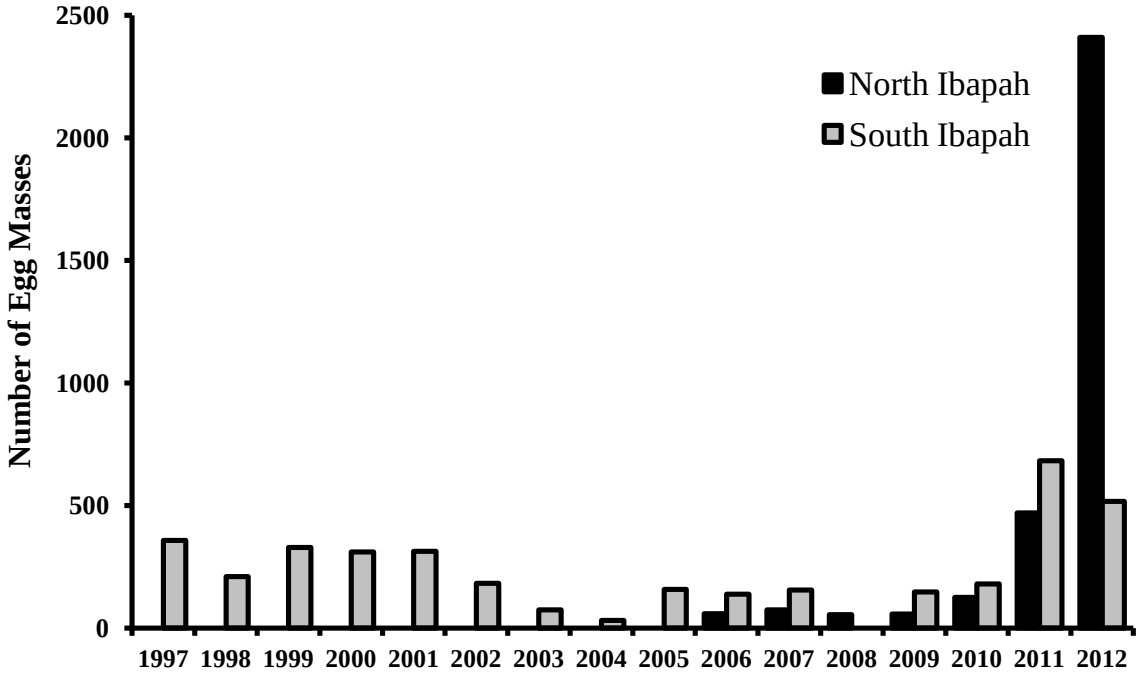

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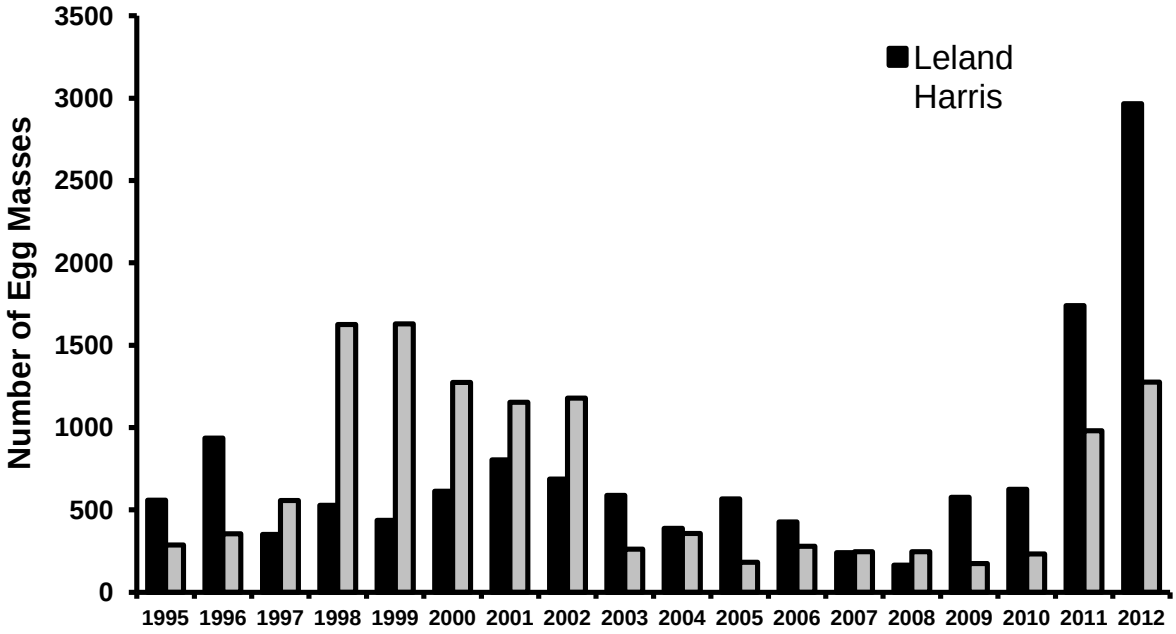

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State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

Columbia Spotted Frog (*Rana luteiventris*) Monitoring Summary 2012

II. Southern Region Report

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EXECUTIVE SUMMARY

In spring 2012, the Utah Division of Wildlife Resources conducted the 16th consecutive year of Columbia Spotted Frog (*Rana luteiventris*) monitoring in southern Snake Valley and Tule Valley, Utah. Visual encounter surveys were conducted at all population locations in the Southern Region for egg masses. In the Southern Region, egg mass numbers at most sites remained consistent with trends of previous years. Egg mass numbers in 2012 indicate stable populations, yet several threats remain to each population and various projects are underway to eliminate or reduce these threats. Continued monitoring should show a population response to these management actions, or indicate areas of additional work necessary to provide for the long-term viability of Columbia Spotted Frog in Utah.

INTRODUCTION

Regional declines and threats to Columbia Spotted Frog (*Rana luteiventris*) populations led the Utah Division of Wildlife Resources (UDWR) to conduct inventories in 1993 and implement Columbia Spotted Frog conservation actions. The Columbia Spotted Frog Conservation Agreement and Strategy (CSFCAS) was developed to coordinate these activities (Perkins and Lentsch 1998; Bailey et al. 2006). A vital component of the CSFCAS is population monitoring in conjunction with habitat and population conservation and restoration activities. In an effort to monitor population trends, assess threats, and assess conservation measures, the UDWR Washington County Field Office has conducted annual population monitoring surveys since 1997 (Fridell et al. 2001). Because of the elusive nature of adult Columbia Spotted Frogs in Utah and difficulty in obtaining accurate population estimates, egg mass counts have been used as a proxy for Columbia Spotted Frog relative abundance. Emerging threats, including proposed pumping from the aquifer supporting Columbia Spotted Frog habitat, emphasize the need for continued monitoring of these isolated populations. Various conservation activities, including non-native removal, habitat improvements, and water restoration, have been conducted in Snake and Tule Valleys to improve conditions for Columbia Spotted Frog.

The CSFCAS describes three Geographic Management Units (GMUs) for the Columbia Spotted Frog: Sevier River, Wasatch Front, and West Desert GMUs (Bailey et al. 2006). The designation of the GMUs is based on hydrologic subregions (United States Geological Survey 1974). Columbia Spotted Frog monitoring locations in the West Desert GMU include: Ibapah Valley, Snake Valley, Tule Valley, and Tooele Valley. This report summarizes monitoring efforts within Tule Valley and the southern portion of Snake Valley (Gandy Marsh, Bishop Springs, and Beck Springs). Columbia Spotted Frog populations in other subregions, as well as Miller Spring and Leland Harris Springs in northern Snake Valley, are monitored and reported by the Central Region of the UDWR.

METHODS

Study Area

Within southern Snake Valley, Gandy Marsh consists of numerous springheads and associated marshes along the western edge of the Gandy Salt Marsh Lake (Figure 1). Bishop Springs, the largest of the areas, contains four springs which feed into confined, fast-flowing streams spreading into numerous channels and large, shallow, open-water marshes (Figure 2). Beck Springs consists of two small springs and associated outflow habitat (Figure 3).

Tule Valley contains 13 individual springs that comprise four geographically isolated marsh complexes. The northern-most marsh complex in Tule Valley is Coyote Spring (Figure 4). The Willow Springs complex consists of Tule 1, Tule 2, and Tule 8, (Figure 5) and the North Tule Springs complex contains Tule 3, Tule 4a, Tule 4b, Tule 4c, and Tule 5 (Figure 6). South Tule Springs (Tule 6: Figure 7) is the southern-most complex. Columbia Spotted Frog reproduction in Tule Valley is monitored within each of these individual springs.

Sampling Design

Monitoring surveys are conducted to document the majority of egg masses deposited at each population location. Area-constrained visual encounter surveys (VESs) are used to locate new egg masses, track survival of previously encountered masses, and ensure that monitoring was conducted during the peak period of egg deposition. Site visits have been coordinated specifically to occur near onset of deposition (defined as the time when approximately ten percent of the average mass total has been deposited), and during peak egg deposition period. Although breeding is dependent on several variables, including weather, temperature, and hydrology, the onset of breeding in Snake and Tule Valleys has remained fairly consistent. Two to three visits are typically made during the peak of egg deposition, these visits being approximately one week apart.

Sampling protocol

VESs were conducted at each site by walking transects along the banks and in shallow water searching for egg clusters, defined as egg masses located in close proximity (less than 0.3 m) to one another. All suitable habitat at each population location is searched. Egg mass age class, number of masses, and location (in UTM coordinates) are recorded on standardized data sheets for each site. Once documented, each cluster of masses is numbered and flagged to identify it in future surveys. Although all egg masses are recorded on subsequent visits to each location, new egg masses are noted separately to obtain a total count for the breeding season. All data is subsequently entered into Excel spreadsheets and reported in annual monitoring reports. Detailed methodology is provided in Fridell et al. (2001) and Wheeler and Fridell (2006).

To prevent the spread of disease, pathogens, or harmful biota between populations, boots and other equipment are disinfected between locations. All mud and debris is removed, and then equipment is sprayed or rinsed in a bath of 1:100 solution of Quat 128 (a

quaternary ammonia compound). This is then rinsed off with water or dried completely before used in another location.

RESULTS

Columbia Spotted Frog monitoring at Tule and southern Snake Valleys was completed between 7 March and 13 April 2012. In 2012, sites were visited two to four times throughout the breeding period. The total number of egg masses detected within each area is presented in Table 1; Table 2 contains the number of egg masses observed at each site annually since 1997. Adult Columbia Spotted Frogs were observed at Gandy Marsh, Bishop Springs, Beck Springs, and Tule Valley. Adult and juvenile northern leopard frogs (*Lithobates pipiens*) were encountered in Snake Valley at Bishop Springs and Gandy Marsh. Age class breakdown of egg masses and observations for sites within Southern Snake Valley and Tule Valley are discussed separately below.

Snake Valley Subunit

At Gandy Marsh, 528 Columbia Spotted Frog egg masses were counted during spring 2012 monitoring (Table 1). There were no egg masses observed when Gandy Marsh was first visited on 7 March. Two weeks later, on 20 March, egg deposition appeared to be peaking when 361 masses were observed. Additional egg masses were found on 4 April and 11 April (Figure 8). For the first time since 2001, egg mass numbers are comparable to pre-2001 when they declined and remained low (Table 2, Figure 9). Since fall 2006, UDWR personnel have been manually restoring spring habitat within Gandy Marsh by removing dense aquatic vegetation and sediment from the springheads. This restoration has provided open water habitat for Columbia Spotted Frog, as well as Least Chub (*Iotichthys phlegethontis*) and other native species. Restoration work was conducted at 21 springs prior to spring 2012 Columbia Spotted Frog monitoring. In 2012, two sites that had previously been restored (springs 54 and 27), but had since deteriorated, had additional vegetation and sediment removed. Restoration work was completed at four additional springs (48, 51, 52, and 55). Also in 2012, over 250 individual purple loosestrife (*Lythrum salicaria*) plants were removed from the southern exclosure at Gandy Marsh.

The largest population of Columbia Spotted Frogs in Snake Valley remains at Bishop Springs with 1,111 egg masses observed during spring 2012 monitoring (Table 1). The onset of egg mass deposition had not yet occurred by 7 March when the location was first visited. Bishop Springs was re-visited on 19 March, 5 April and 12 April (Figure 10). Peak egg deposition was occurring on 5 April. The number of Columbia Spotted Frog egg masses observed at Bishop Springs in 2012 is higher than any year previously monitored (Table 2, Figure 11). In January and February 2012, Russian olive (*Elaeagnus angustifolia*) was removed from Spotted Frog and its associated outflow. Trees were cut with an armored excavator with a mastication head to shred the trees, as well as chainsaws. Stumps were sprayed with Element 3A and Element 4 herbicide (the generic equivalent of Garlon) to prevent regrowth.

At Beck Springs, 304 Columbia Spotted Frog egg masses were observed during spring 2012 monitoring (Table 1). A total of 205 egg masses were observed in the north spring during the first visit on 7 March; peak egg deposition had likely occurred. Additional visits were made on 19 March and 6 April (Figure 12). The number of Columbia Spotted Frog egg masses observed during spring 2012 was the second highest since the population was discovered in 2005, and only one mass lower than the highest (Table 2, Figure 13).

Tule Valley Subunit

At Coyote Spring, 1,352 egg masses were observed during spring 2012 monitoring. During the first visit on 8 March, 77 masses were observed, indicating that onset had probably not yet occurred, but would soon. Peak deposition had occurred by 21 March (Figure 14). Numbers of egg masses observed at Coyote Springs were similar to historic trends (Figure 15). Egg masses at Coyote Spring comprised 44.8% of all egg masses observed in Tule Valley. Tamarisk removal completed between 2008 and 2011 has improved much of the wetland habitat on the northern portion of the marsh, and Columbia Spotted Frog egg masses were found in this restored habitat in 2012.

A total of 482 egg masses were observed in the Willow Springs Complex, which consists of Tule 1, 2, and 8. Peak deposition had already occurred at Tule 1 when the locations were first visited on 22 March, but numbers of newly observed masses were greater at Tule 2 on 3 April (Figure 16). One egg mass was observed at Tule 8, the first one observed since 1997. The number off egg masses observed in the complex was the second highest documented since monitoring began in 1997 (Figure 17). The number in Tule 1 (n=343) was the highest ever observed. The egg mass at Tule 8 indicates successful reproduction at that site, after continued reintroduction of egg masses each year since 2008. Sediment and vegetation were removed from portions of this wetland to improve breeding habitat.

A total of 994 egg masses were observed in the North Tule Springs Complex, which consists of Tule 3, Tule 4a, Tule 4b, Tule 4c, and Tule 5. Egg deposition onset had occurred previous to the first visit on 8 March, and had peaked with 308 masses by the second visit on 22 March. Other locations, with the exception of Tule 2, had also peaked by 22 March (Figure 18). Tule 2 was peaking during the third visit on 3 April with 138 masses. The egg mass total for 2012 was lower than those observed since 2007, but remained within typical range (Figure 19). Egg masses at North Tule Springs comprised 33.0% of all egg masses observed in Tule Valley.

At South Tule Springs, 187 egg masses were observed. Peak deposition had already occurred by 22 March. Onset likely occurred two weeks before (Figure 20). The total egg mass count for 2012 was higher than has been documented previously (Figure 21).

DISCUSSION

Columbia Spotted Frog egg mass counts in southern Snake Valley and Tule Valley

indicate that populations remain stable. Egg mass numbers in southern Snake Valley were higher than average; more were documented at Bishop Springs than has been observed previously there. Egg mass numbers had declined at Gandy Marsh in 2002, but 2012 numbers compare with those previous to this decline. Three sites in Tule Valley (Tule 1, Tule 4b, and Tule 6) contained more egg masses than have ever been observed previously, although overall population numbers remained similar to previous years.

Since 2006, 25 springheads in Gandy Marsh have been restored through the manual removal of sediment and overgrown vegetation. Columbia Spotted Frogs have responded positively to this restoration, and egg masses were observed in restored springheads. Additional spring restoration activities are being conducted. In 2012, vegetation and sediment were removed from four springs, and two additional springs that were previously restored had additional maintenance performed.

Non-native plants, particularly Russian olive (*Elaeagnus angustifolia*) in Bishop Springs and purple loosestrife in Gandy Marsh, are potential threats to Columbia Spotted Frog habitat and efforts to control or remove these invasive plants are a priority. In January and February 2012, 28 acres of Russian olives were removed with a bullhog and chainsaws from Foote Spring and its outflow in the Bishop Springs complex. Stumps were sprayed with herbicide to reduce re-growth. Also in 2012, all of the purple loosestrife found in Gandy Marsh (spread throughout 0.37 hectares, or 0.91 acres) were removed from the southern exclosure.

At South Beck Spring, additional frog breeding habitat may be created by increasing the depth of the outflow pool. Continued habitat restoration and population supplementation at Tule 8, where one egg mass, the first observed since 1997, is ongoing. A population of introduced Southern Platyfish (*Xiphophorus maculates*), a tropical aquarium fish, was discovered in Tule 4a in 2007. Adverse potential impacts of platyfish on Columbia Spotted Frog populations are currently unknown and should be evaluated.

RECOMMENDATIONS

Active recovery actions are necessary to manage and protect Columbia Spotted Frog populations in southern Snake Valley and Tule Valley from threats including invasive non-native species, habitat degradation due to grazing, and potential future groundwater withdrawal. Continued monitoring is necessary to evaluate potential impacts from these threats and the population level response to implementation of conservation projects.

ACKNOWLEDGEMENTS

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TABLES

Table 1. Total number of Columbia Spotted Frog egg masses observed by age class (AC) in southern Snake Valley and Tule Valley, spring 2012.

Site	AC 1	AC 2	AC 3 & 3+	Dead	Total
Gandy Marsh	**455**	**13**	**59**	**1**	**528**
Bishop Springs	**592**	**177**	**342**	**0**	**1,111**
Beck Springs	**228**	**58**	**18**	**0**	**304**
Coyote Spring	**1,116**	**79**	**10**	**147**	**1,352**
Willow Springs Complex	**364**	**115**	**1**	**2**	**482**
North Tule Springs Complex	**521**	**206**	**235**	**32**	**994**
South Tule Springs	**105**	**39**	**41**	**2**	**187**

Table 2. Total number of Columbia Spotted Frog egg masses found in southern Snake and Tule Valleys, 1997 - 2012.

Year	Gandy Marsh	Bishop Springs	Beck Springs	Coyote Spring	Willow Springs Complex	North Tule Springs Complex	South Tule Springs
1997	406	Not surveyed	Not surveyed	957	129	290	35
1998	489	275	Not surveyed	Not Surveyed	Not Surveyed	441	Not Surveyed
1999	672	274	Not surveyed	651	111	385	72
2000	784	241	Not surveyed	950	108	573	0
2001	585	201	Not surveyed	1,124	151	868	34
2002	90	357	Not surveyed	1,282	217	685	19
2003	115	615	Not surveyed	2,585	185	1,079	21
2004	131	213	Not surveyed	1,039	108	179	3
2005	155	325	Not surveyed	1,375	186	590	1
2006	205	425	89	1,309	195	869	24
2007	114	891	82	1,072	270	767	22
2008	128	715	120	1,066	216	1,008	12
2009	121	704	156	1,850	324	1,748	150
2010	185	511	141	1,189	439	1,703	60
2011	256	745	305	1,442	556	1,147	156
2012	528	1,111	304	1,352	482	994	187

FIGURES

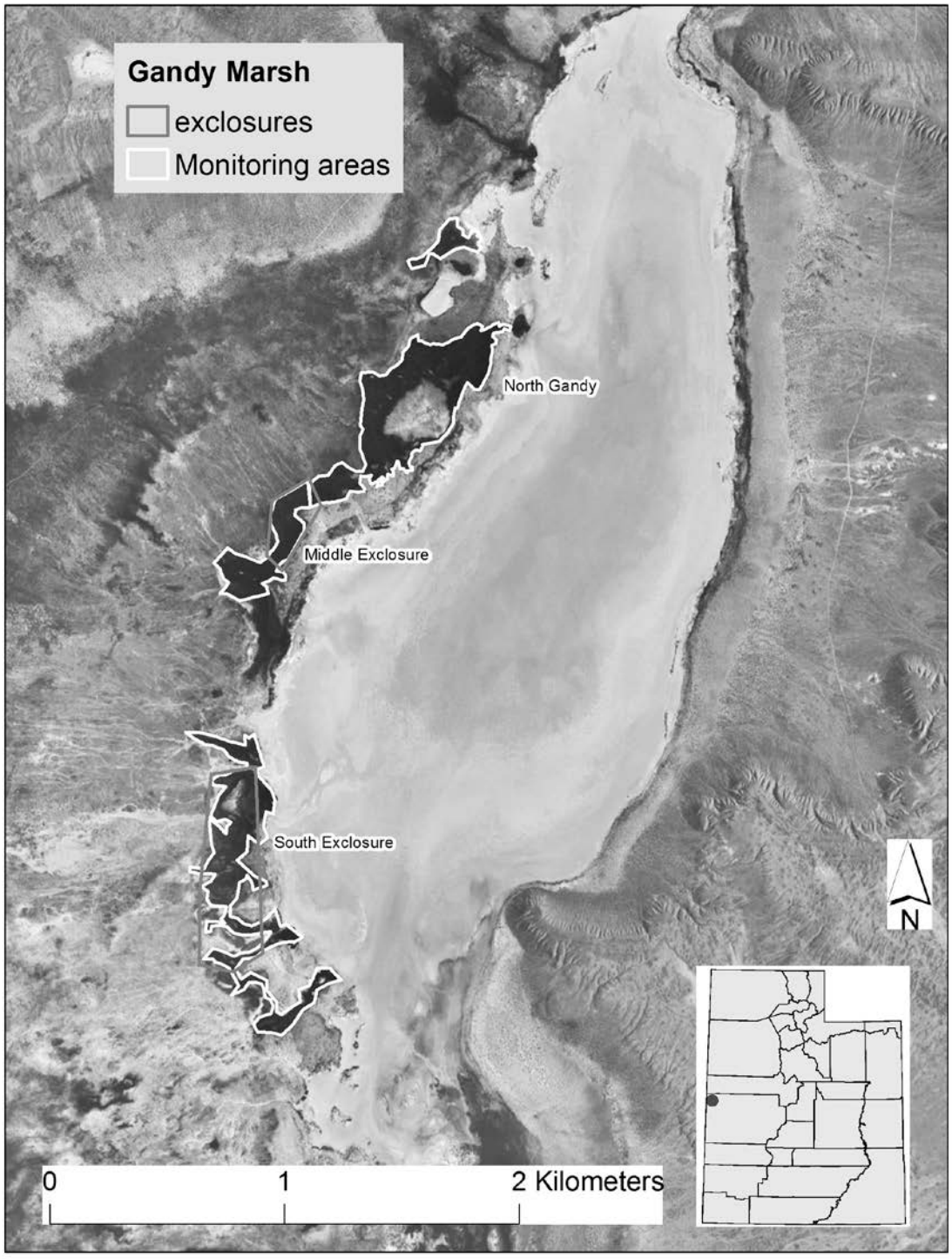

Figure 1. Location of Gandy Marsh Columbia Spotted Frog monitoring areas, Snake Valley, Utah (Gandy Quadrangle, 7.5 minute series).

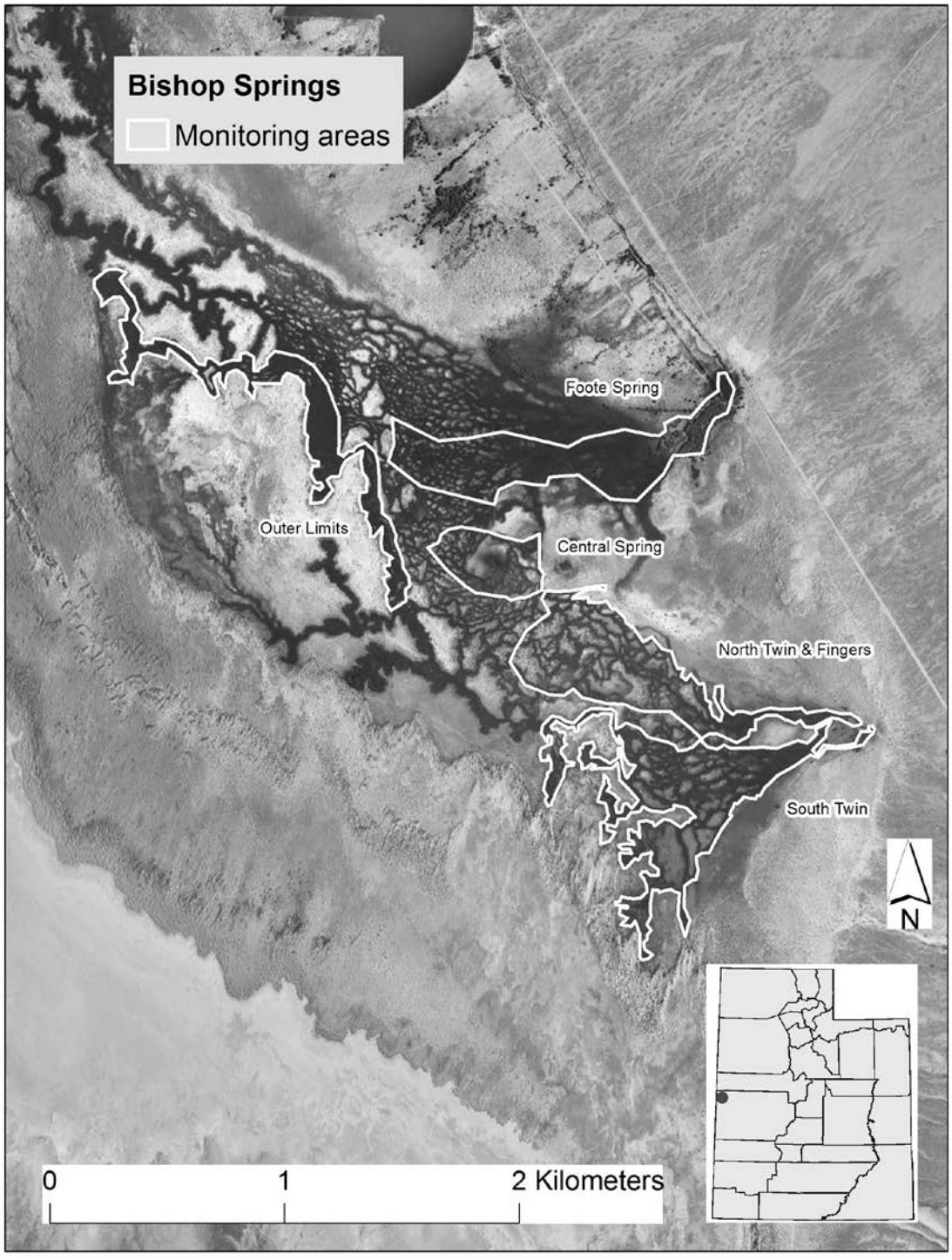

Figure 2. Location of Bishop Springs Columbia Spotted Frog monitoring areas, Snake Valley, Utah (Gandy and Foote Range Quadrangles, 7.5 minute series).

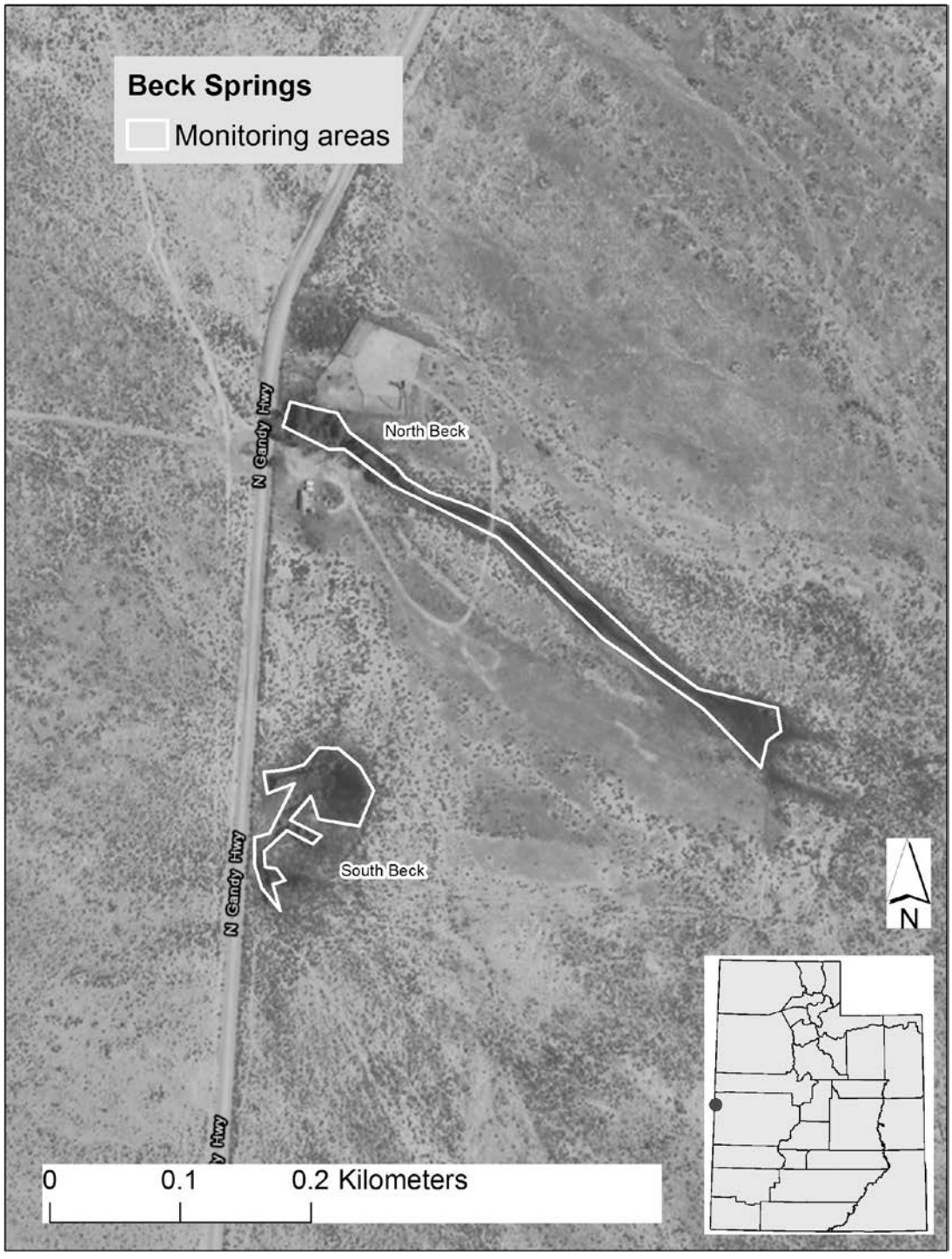

Figure 3. Location of Beck Springs Columbia Spotted Frog monitoring areas, Snake Valley, Utah (The Cove Quadrangle, 7.5 minute series).

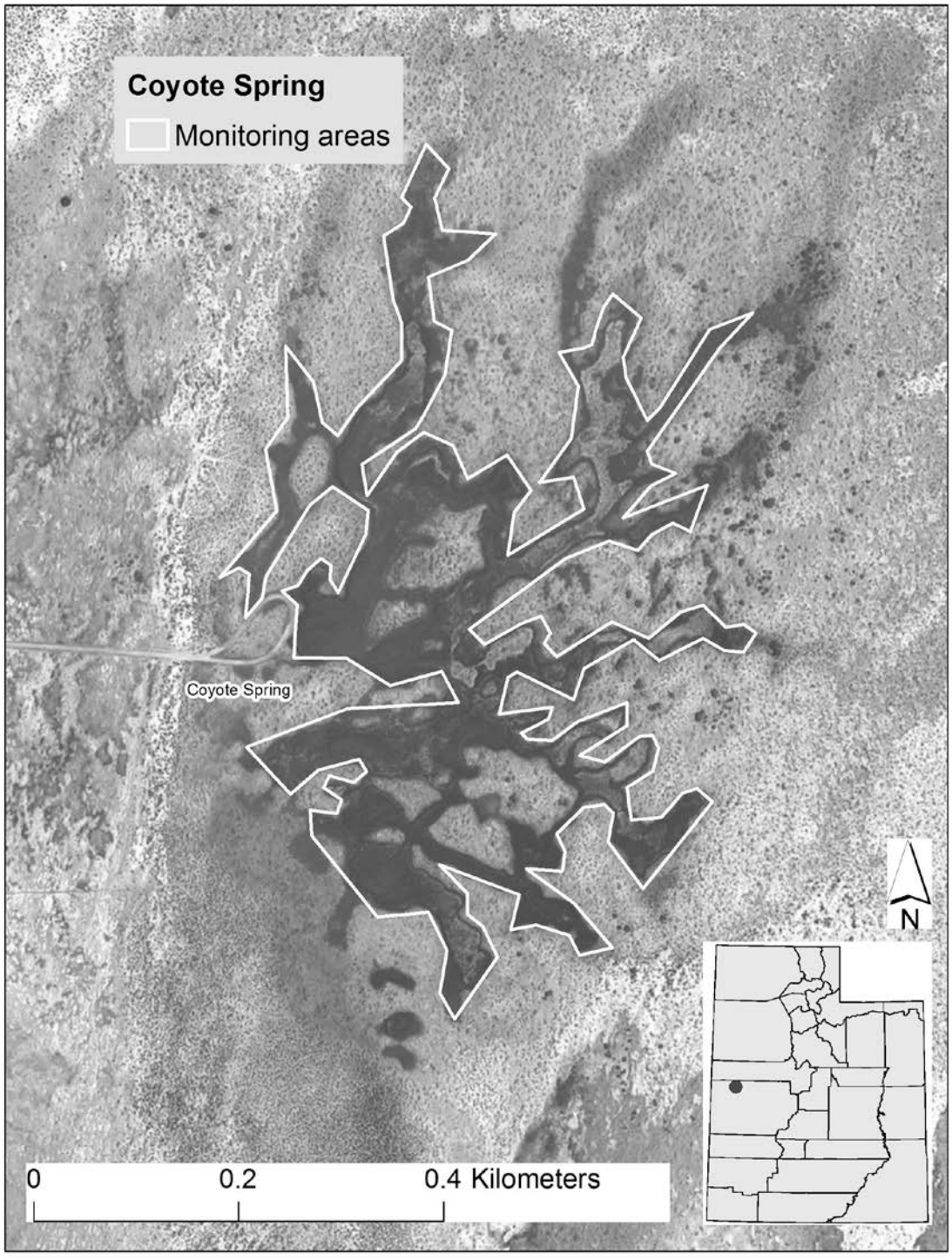

Figure 4.Location of Coyote Spring Columbia Spotted Frog monitoring areas, Tule Valley, Utah (Coyote Knolls Quadrangle, 7.5 minute series).

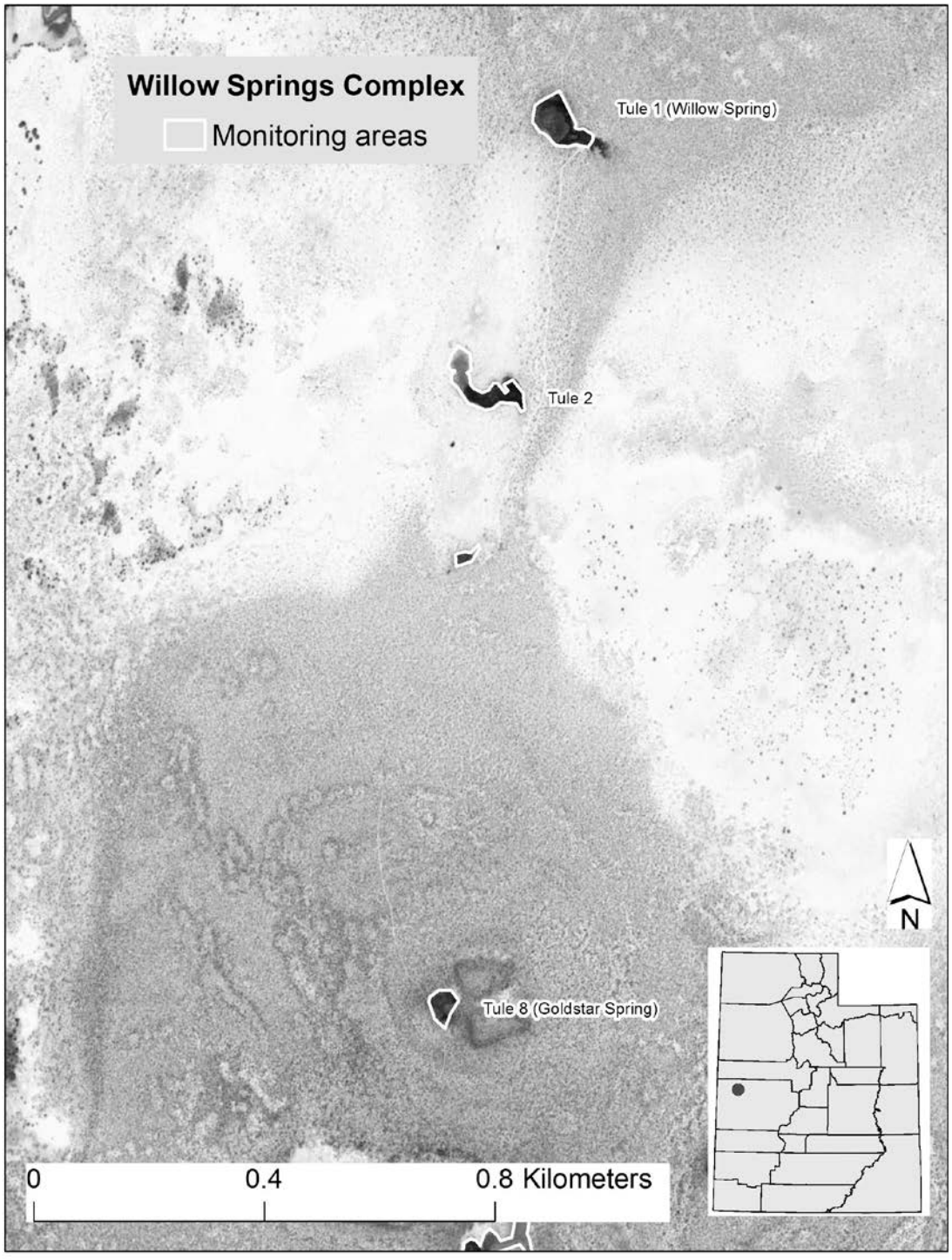

Figure 5. Location of Willow Springs complex Columbia Spotted Frog monitoring areas, Tule Valley, Utah (Chalk Knolls Quadrangle, 7.5 minute series).

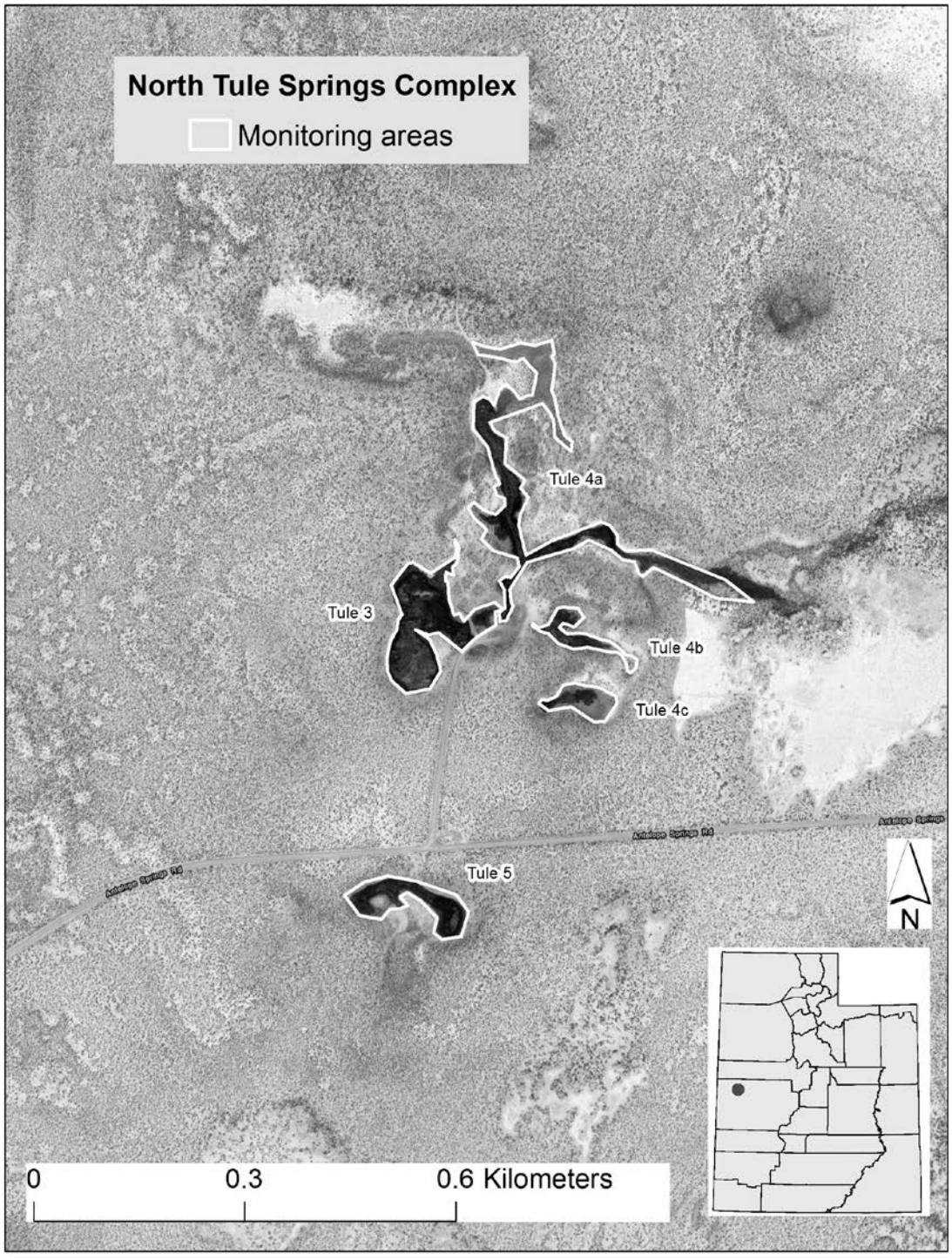

Figure 6. Location of North Tule Springs complex Columbia Spotted Frog monitoring areas, Tule Valley, Utah (Chalk Knolls Quadrangle, 7.5 minute series).

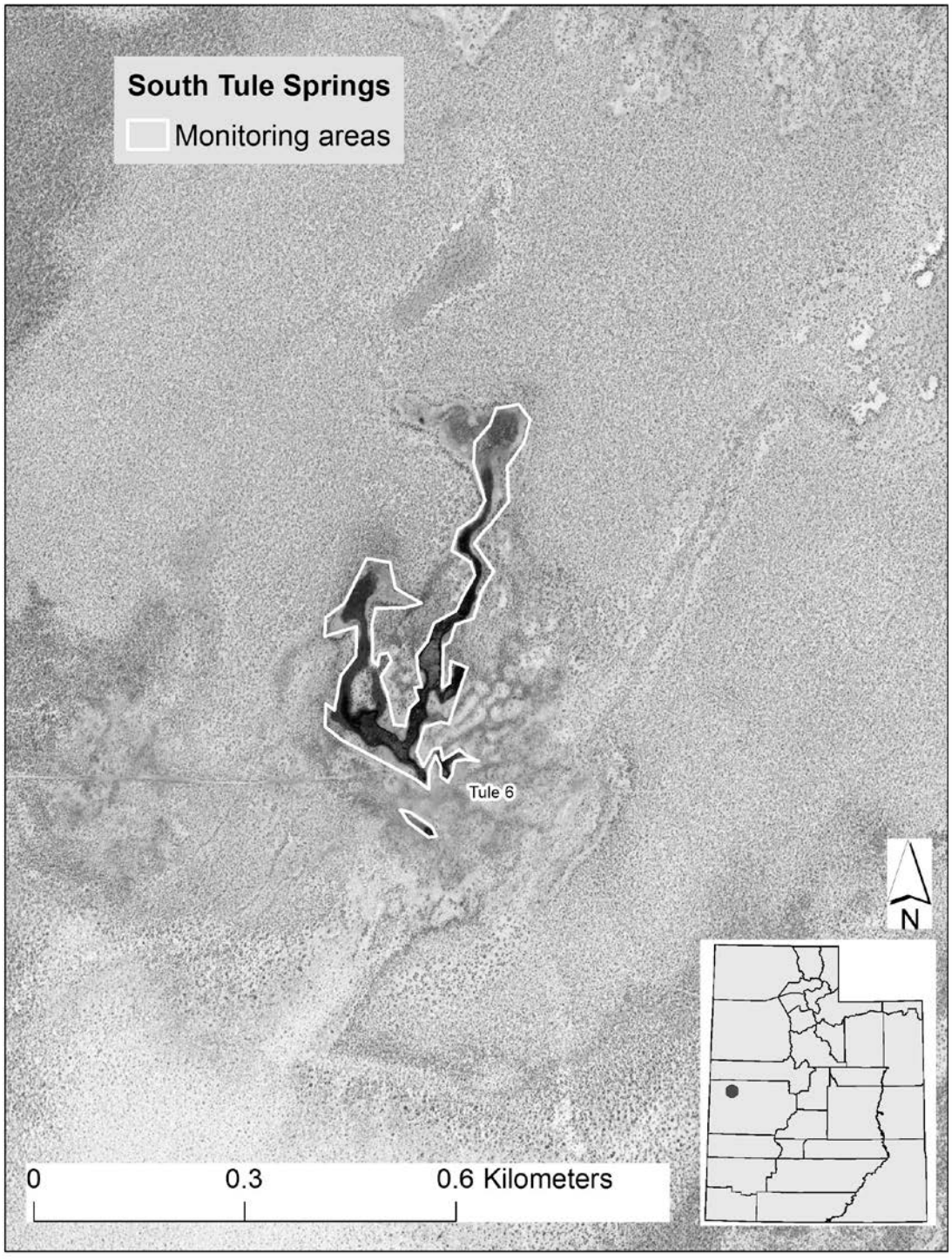

Figure 7. Location of South Tule Springs Columbia Spotted Frog monitoring areas, Tule Valley, Utah (Chalk Knolls Quadrangle, 7.5 minute series).

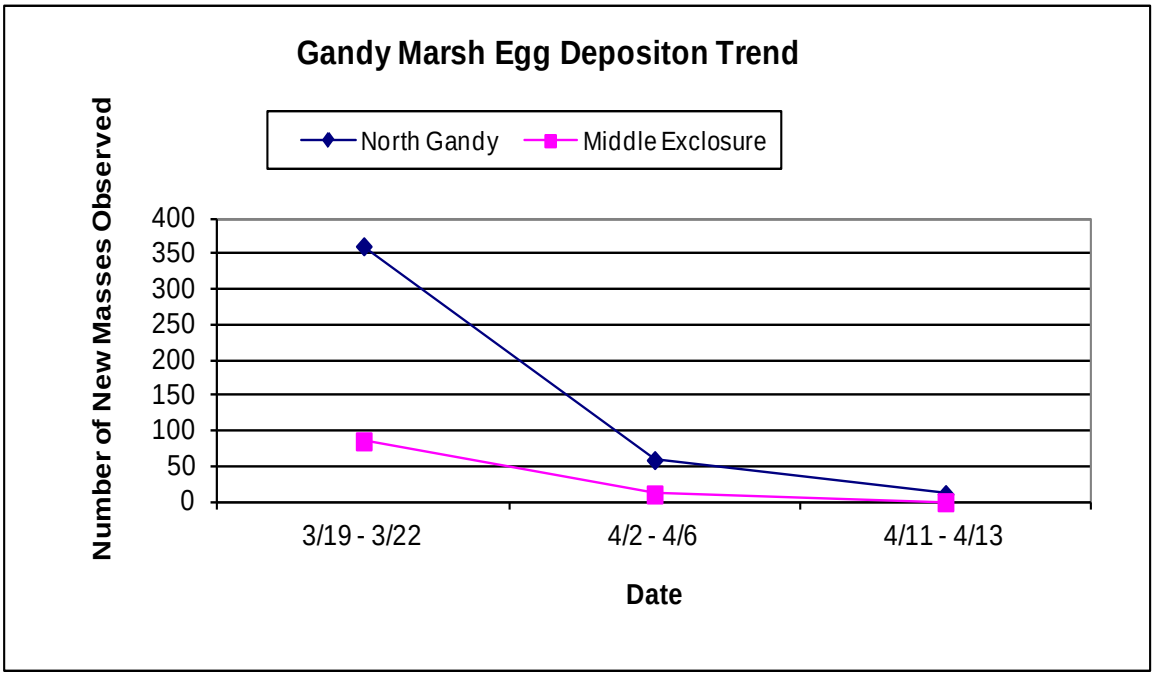

Figure 8. Columbia Spotted Frog egg mass deposition trend observed at Gandy Marsh during spring 2012.

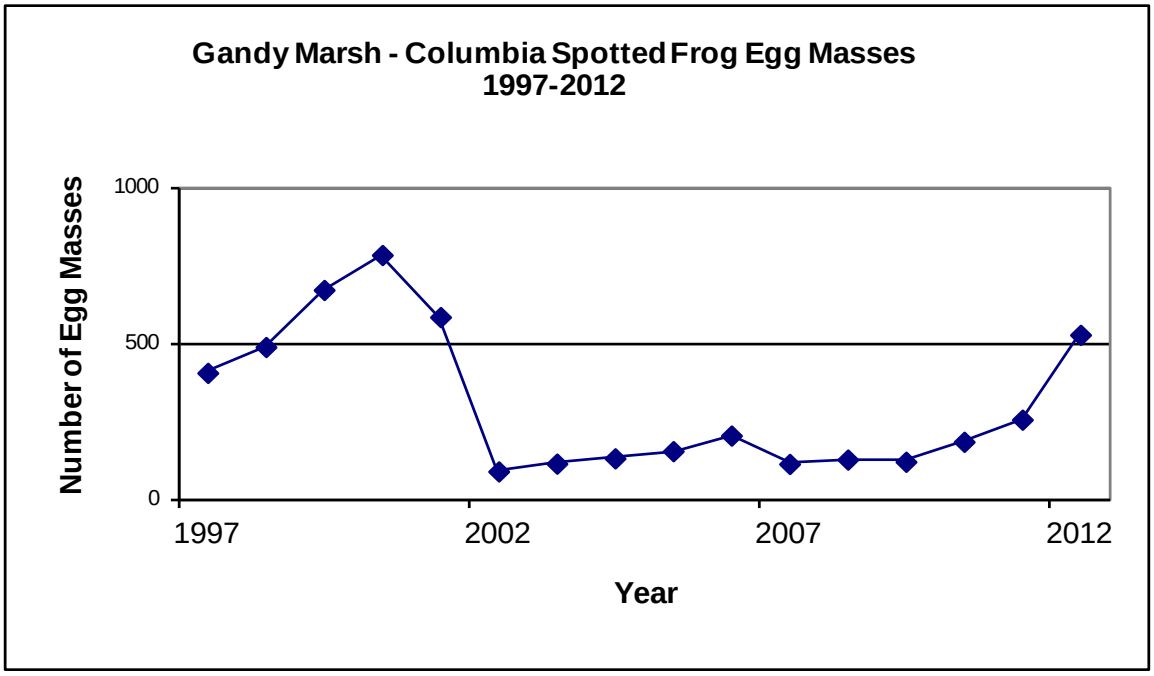

Figure 9. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1997 to 2012 at Gandy Marsh, Utah.

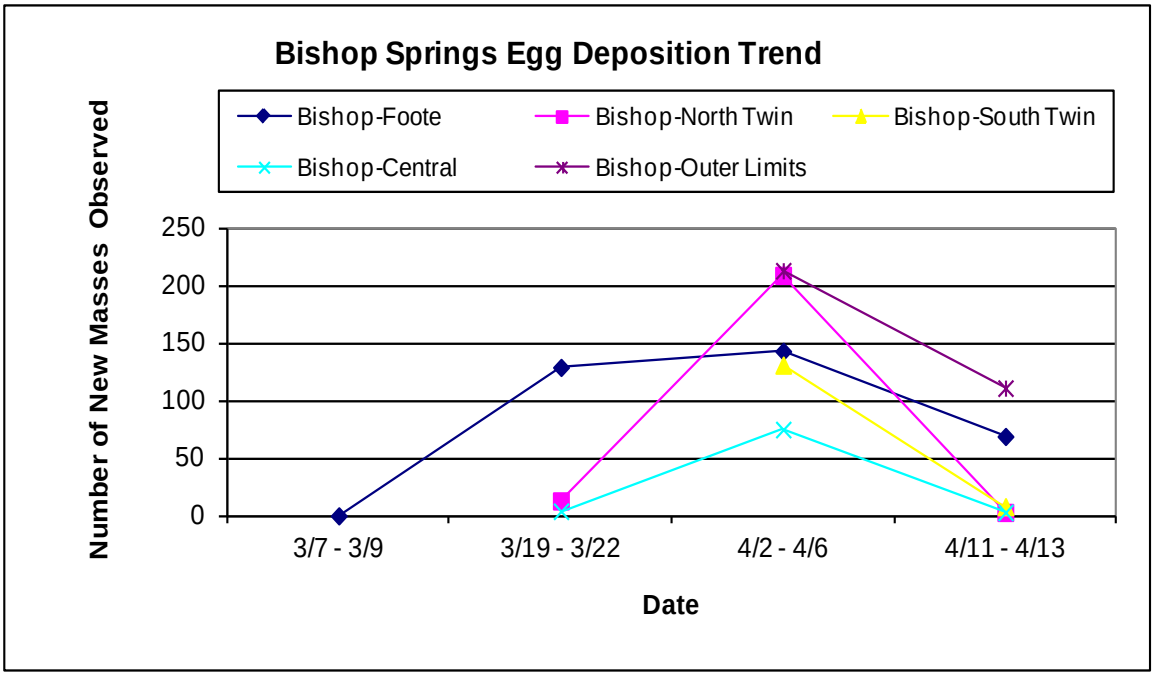

Figure 10. Columbia Spotted Frog egg mass deposition trend observed at Bishop Springs during spring 2012.

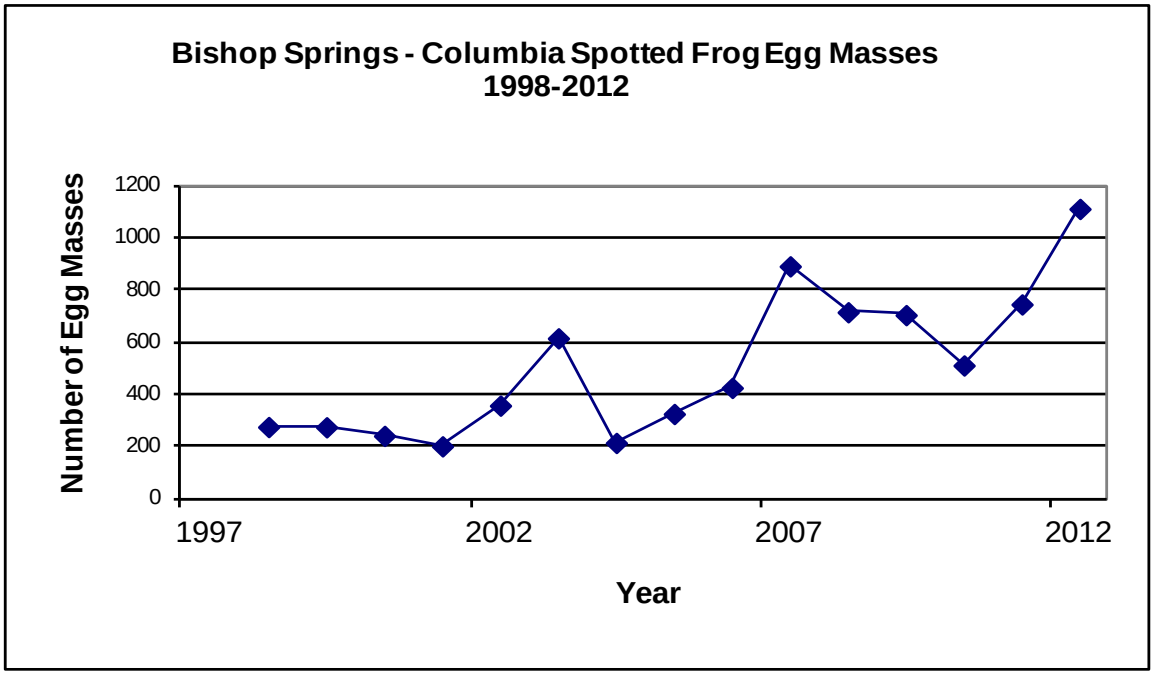

Figure 11. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1998 to 2012 at Bishop Springs, Utah.

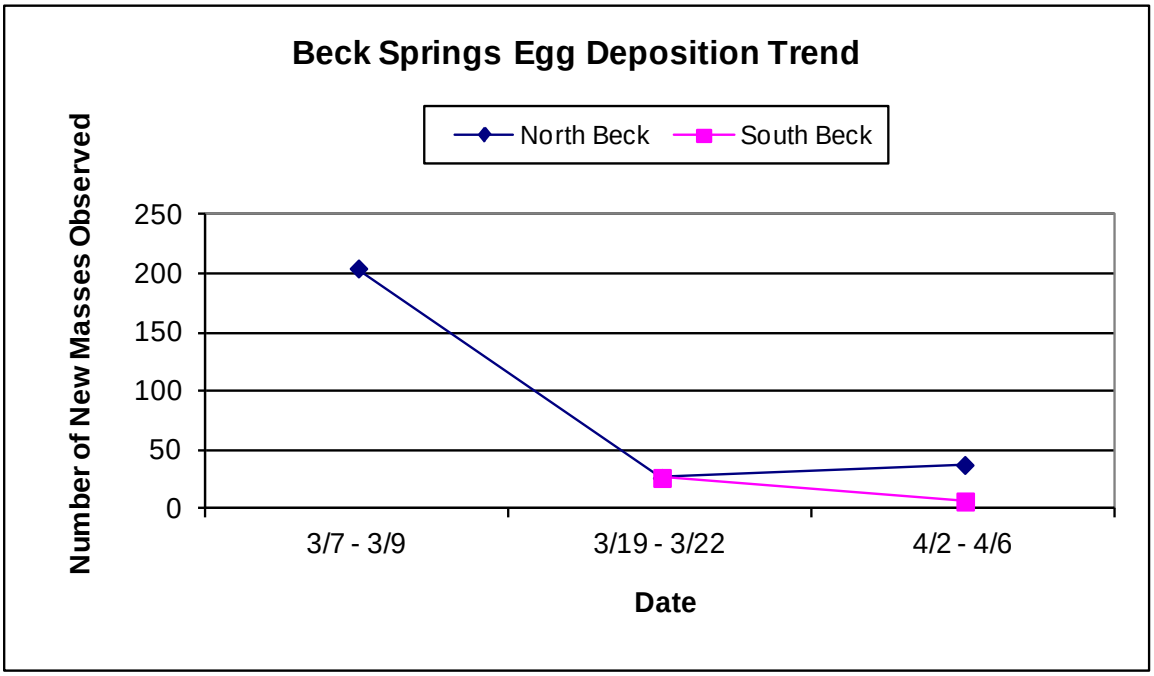

Figure 12. Columbia Spotted Frog egg mass deposition trend observed at Beck Springs during spring 2012.

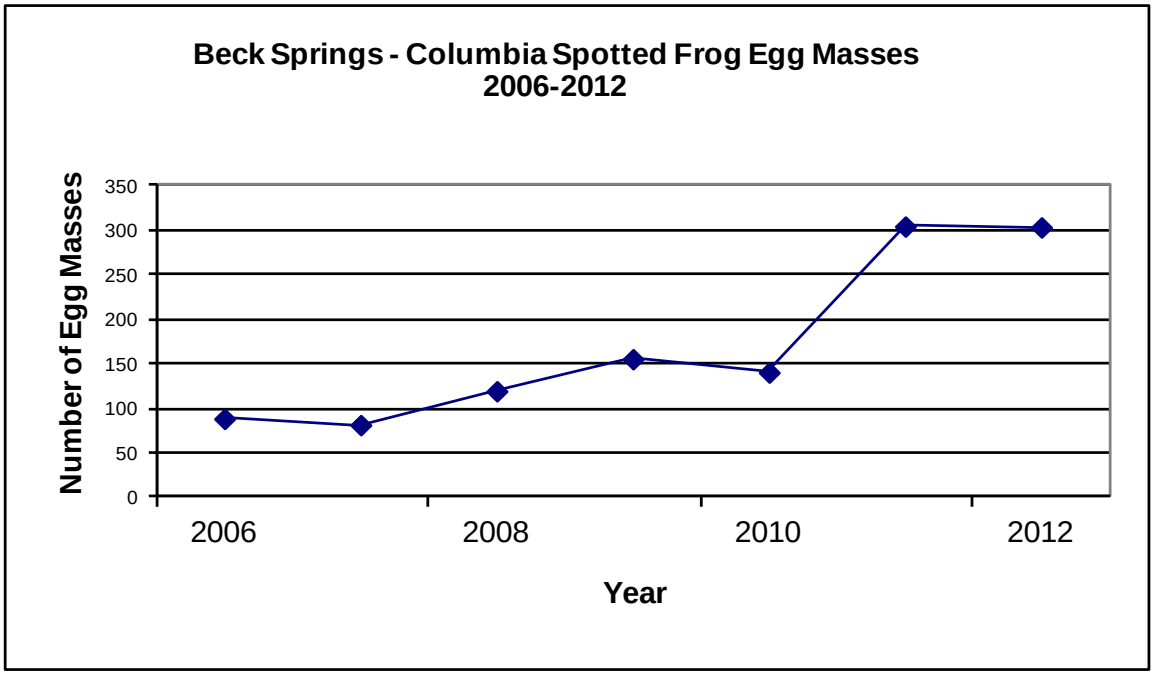

Figure 13. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 2006 to 2012 at Beck Springs, Utah.

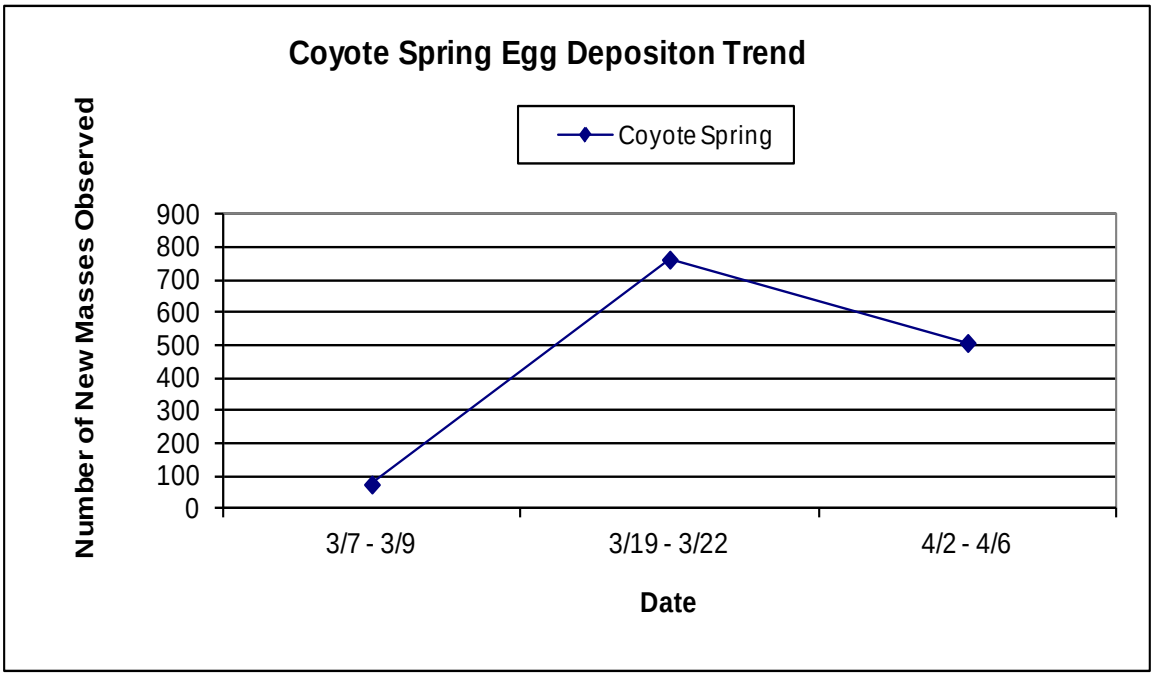

Figure 14. Columbia Spotted Frog egg mass deposition trend observed at Coyote Spring during spring 2012.

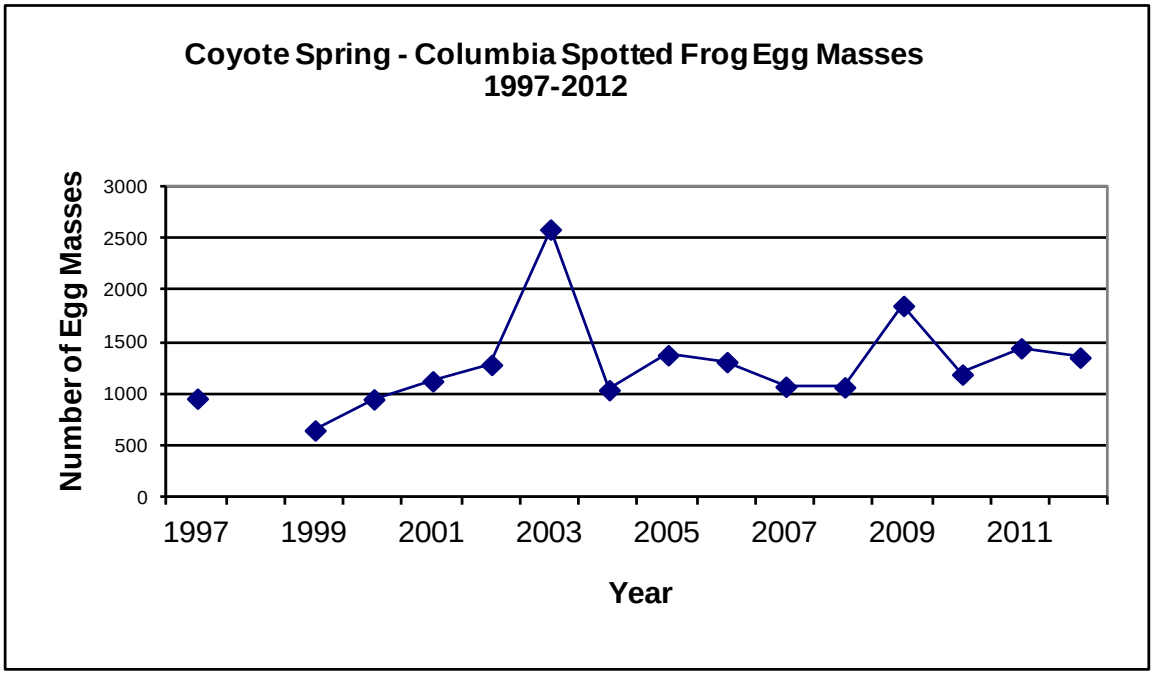

Figure 15. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1997 to 2012 at Coyote Spring, Utah.

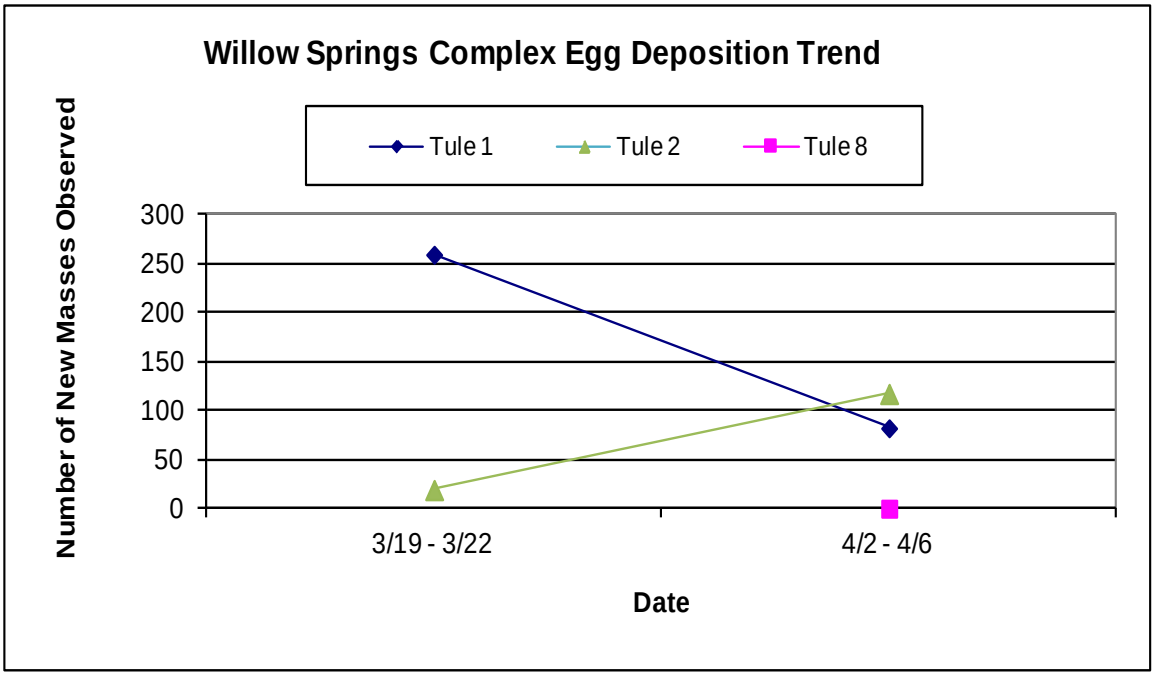

Figure 16. Columbia Spotted Frog egg mass deposition trend observed at the Willow Springs Complex during spring 2012.

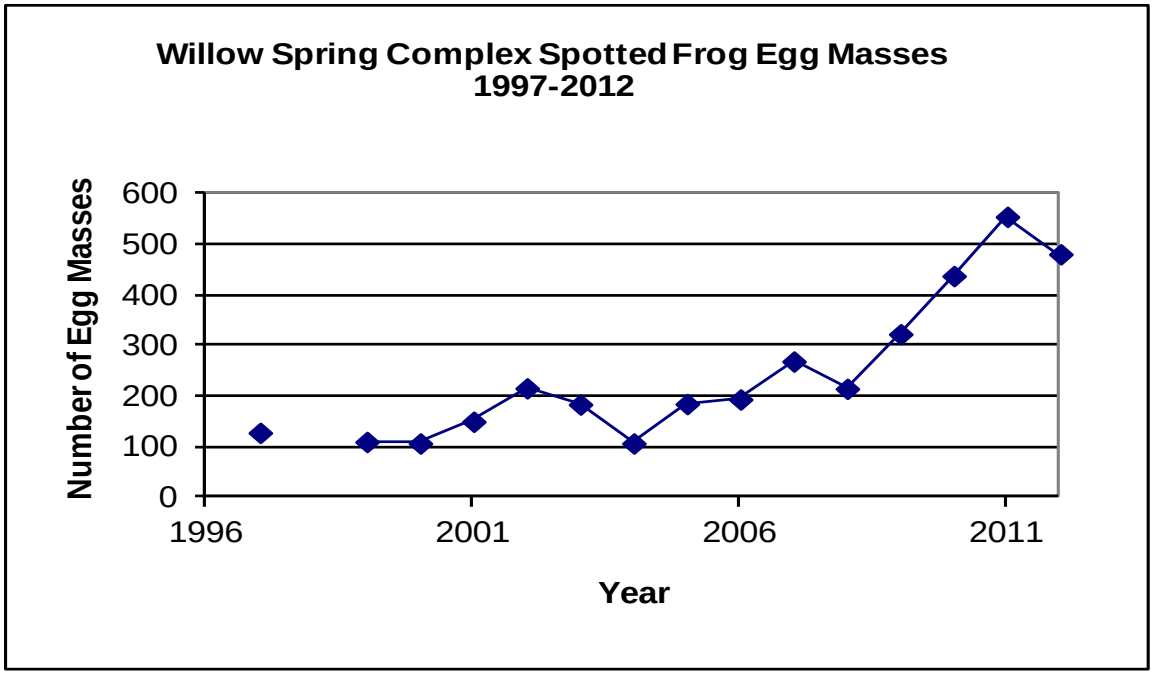

Figure 17. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1997 to 2012 at the Willow Springs Complex, Utah.

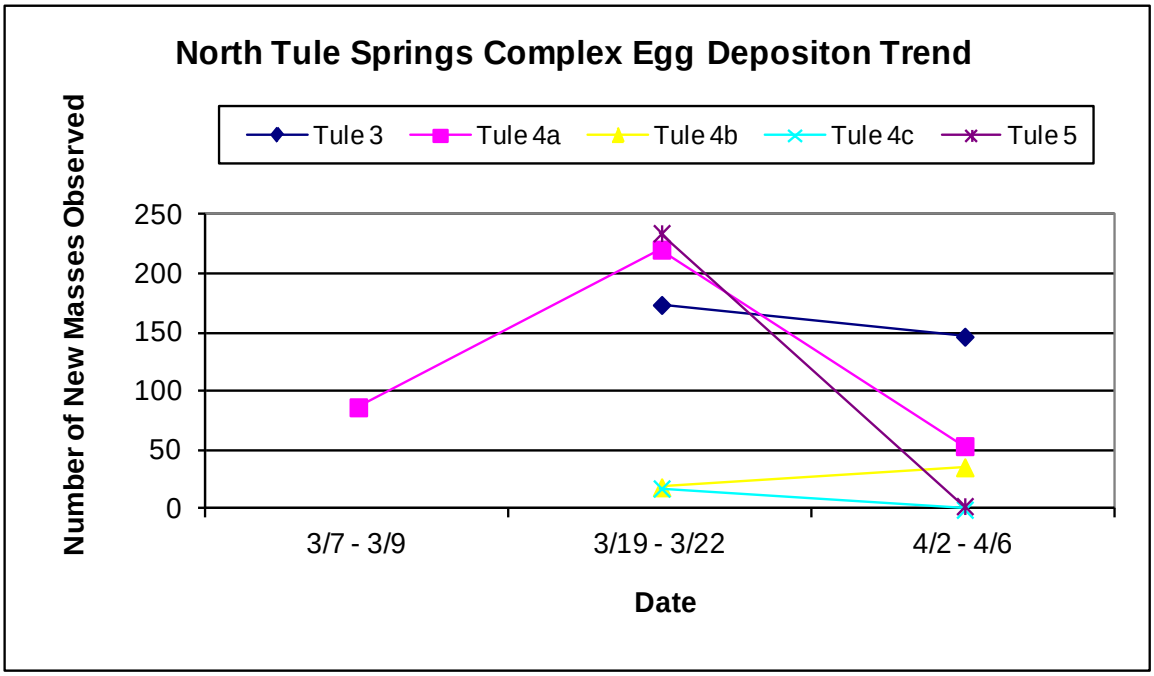

Figure 18. Columbia Spotted Frog egg mass deposition trend observed at the North Tule Springs Complex during spring 2012.

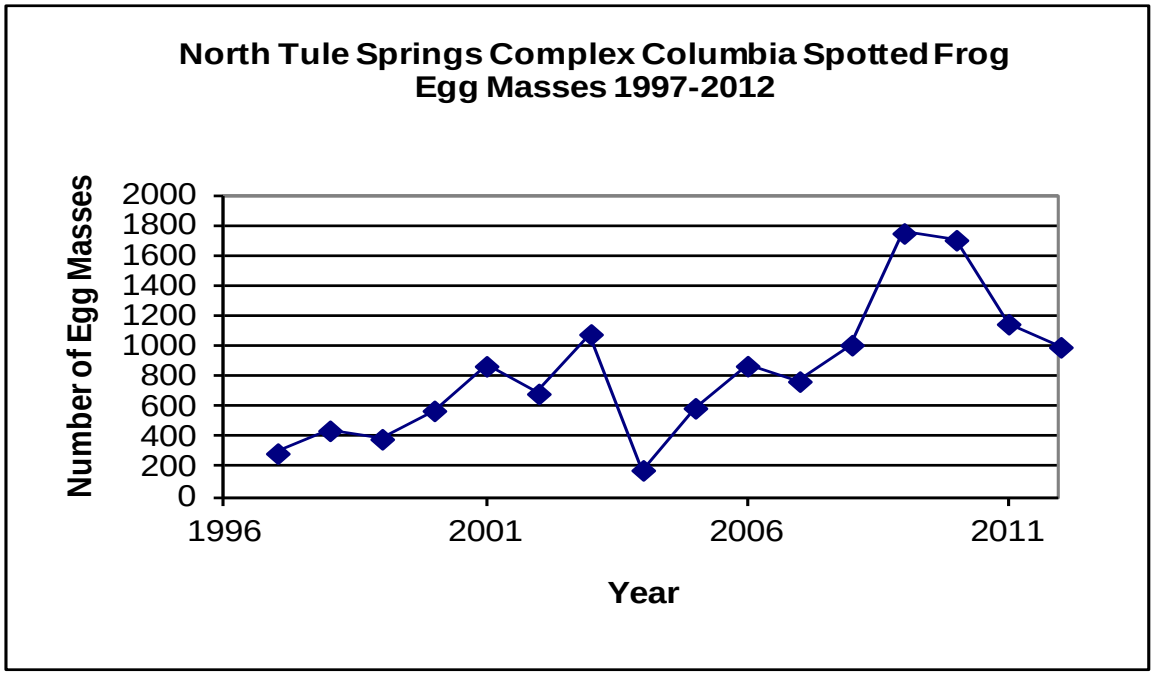

Figure 19. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1997 to 2012 at the North Tule Springs Complex, Utah.

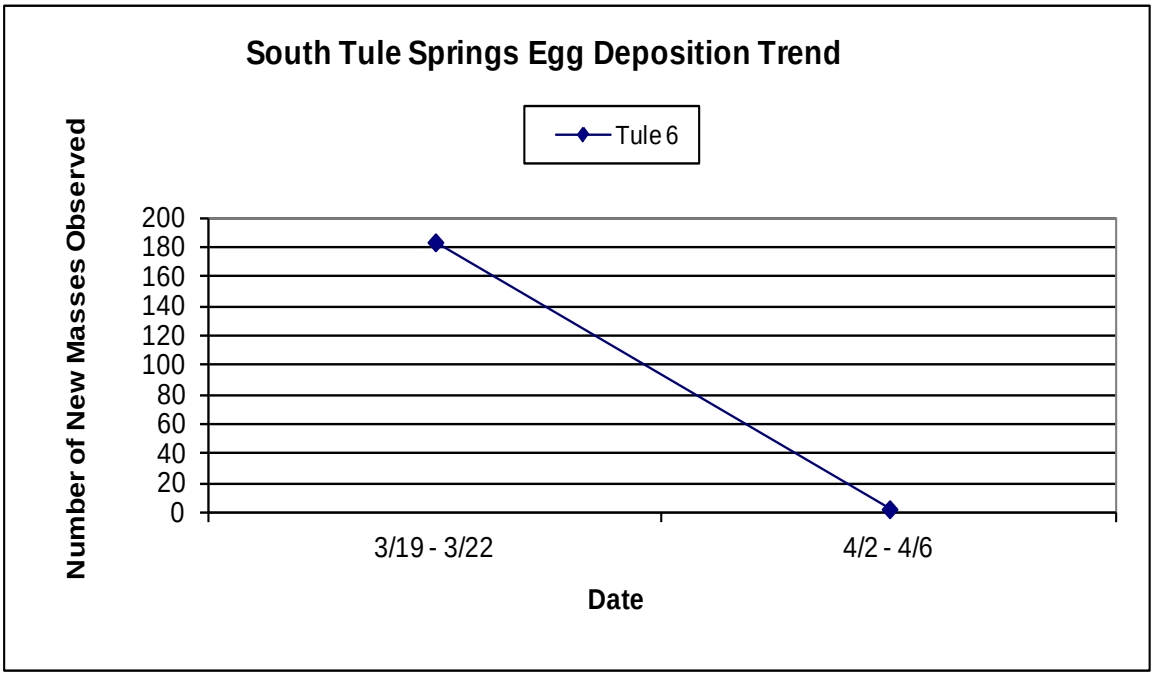

Figure 20. Columbia Spotted Frog egg mass deposition trend observed at the South Tule Springs during spring 2012.

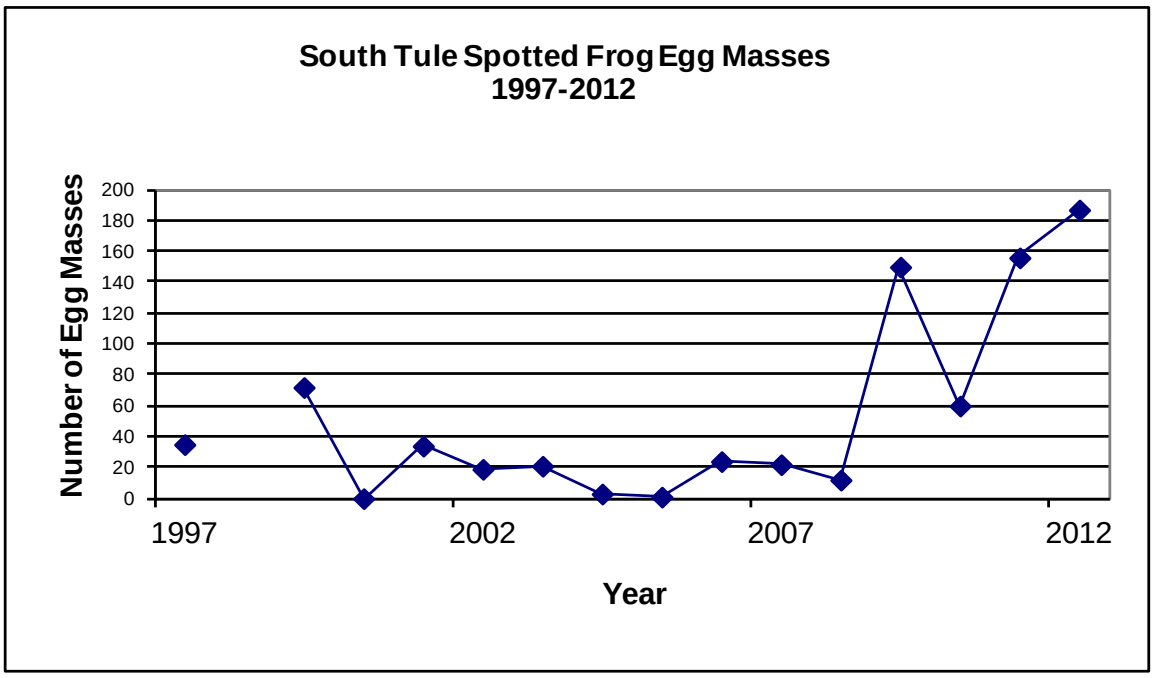

Figure 21. Number of Columbia Spotted Frog egg masses observed during annual monitoring from 1997 to 2012 at the South Tule Springs, Utah.